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ESSAYS

SCIENTIFIC, POLITICAL, AND SPECULATIVE

VOLUME II

ESSAYS

SCIENTIFIC, POLITICAL, AND SPECULATIVE

BY

HERBERT SPENCER

IN THREE VOLUMES

VOLUME II

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THE GENESIS OF SCIENCE.

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THERE still prevails among men a vague notion that scientific knowledge differs in nature from ordinary knowledge. By the Greeks, with whom Mathematics—literally *things learnt*—was alone considered as knowledge proper, the distinction must have been strongly felt; and it has ever since maintained itself in the general mind. Though, considering the contrast between the achievements of science and those of daily unmethodic thinking, it is not surprising that such a distinction has been assumed; yet it needs but to rise a little above the common point of view, to see that it is but a superficial distinction. The same faculties are employed in both cases; and in both cases their mode of operation is fundamentally the same. If we say that science is organized knowledge, we are met by the truth that all knowledge is organized in a greater or less degree—that the commonest actions of the household and the field presuppose facts colligated, inferences drawn, results expected; and that the general success of these actions proves the data by which they were guided to have been correctly put together. If, again, we say that science is prevision—is a seeing beforehand—is a knowing in what

times, places, combinations, or sequences, specified phenomena will be found; we are obliged to confess that the definition includes much that is foreign to science in its ordinary acceptation: for example, a child's knowledge of an apple. This, as far as it goes, consists in previsions. When a child sees a certain form and colours, it knows that if it puts out its hand it will have certain impressions of resistance, and roundness, and smoothness; and if it bites, a certain taste. And manifestly its general acquaintance with surrounding objects is of like nature—is made up of facts concerning them, grouped so that any part of a group being perceived, the existence of the other facts included in it is foreseen. If, once more, we say that science is *exact* prevision, we still fail to establish the supposed difference. Not only do we find that much of what we call science is not exact, and that some of it, as physiology, can never become exact; but we find further, that many of the previsions constituting the common stock alike of wise and foolish, *are* exact. That an unsupported body will fall; that a lighted candle will go out when immersed in water; that ice will melt when thrown on the fire—these, and many like predictions relating to the familiar properties of things, have as high a degree of accuracy as predictions are capable of. It is true that the results foreseen are of a very general character; but it is none the less true that they are correct as far as they go: and this is all that is requisite to fulfil the definition. There is perfect accordance between the anticipated phenomena and the actual ones; and no more than this can be said of the highest achievements of the sciences specially characterized as exact.

Seeing thus that the assumed distinction between scientific knowledge and common knowledge cannot be sustained; and yet feeling, as we must, that however impossible it may be to draw a line between them, the two are not practically identical; there arises the question—What is the relationship

between them? A partial answer to this question may be drawn from the illustrations just given. On reconsidering them, it will be observed that those portions of ordinary knowledge which are identical in character with scientific knowledge, comprehend only such combinations of phenomena as are directly cognizable by the senses, and are of simple, invariable nature. That the smoke from a fire which she is lighting will ascend, and that the fire will presently boil the water placed over it, are previsions which the servant-girl makes equally well with the most learned physicist; but they are previsions concerning phenomena in constant and direct relation—phenomena that follow visibly and immediately after their antecedents—phenomena of which the causation is neither remote nor obscure—phenomena which may be predicted by the simplest possible act of reasoning. If, now, we pass to the previsions constituting science—that an eclipse of the moon will happen at a specified time; that when a barometer is taken to the top of a mountain of known height, the mercurial column will descend a stated number of inches; that the poles of a galvanic battery immersed in water will give off, the one an inflammable and the other an inflaming gas, in definite ratio—we perceive that the relations involved are not of a kind habitually presented to our senses. They depend, some of them, on special combinations of causes; and in some of them the connexion between antecedents and consequents is established only by an elaborate series of inferences. A broad distinction, therefore, between scientific knowledge and common knowledge is its remoteness from perception. If we regard the cases in their most general aspect, we see that the labourer who, on hearing certain notes in the adjacent hedge, can describe the particular form and colours of the bird making them, and the astronomer who, having calculated a transit of Venus, can delineate the black spot entering on the sun's disc, as it will appear through the telescope, at a specified hour, do

essentially the same thing. Each knows that on fulfilling the requisite conditions, he shall have a preconceived impression—that after a definite series of actions will come a group of sensations of a foreknown kind. The difference, then, is neither in the fundamental character of the mental acts; nor in the correctness of the previsions accomplished by them; but in the complexity of the processes required to achieve the previsions. Much of our common knowledge is, as far as it goes, precise. Science does not increase its precision. What then does it do? It reduces other knowledge to the same degree of precision. That certainty which direct perception gives us respecting coexistences and sequences of the simplest and most accessible kind, science gives us respecting coexistences and sequences, complex in their dependencies, or inaccessible to immediate observation. In brief, regarded from this point of view, science may be called *an extension of the perceptions by means of reasoning.*

On further considering the matter, however, it will perhaps be felt that this definition does not express the whole fact—that inseparable as science may be from common knowledge, and completely as we may fill up the gap between the simplest previsions of the child and the most recondite ones of the physicist, by interposing a series of previsions in which the complexity of reasoning involved is greater and greater, there is yet a difference between the two beyond that above described. And this is true. But the difference is still not such as enables us to draw the assumed line of demarcation. It is a difference not between common knowledge and scientific knowledge; but between the successive phases of science itself, or knowledge itself—whichever we choose to call it. In its earlier phases science attains only to *certainty* of foresight; in its later phases it further attains to *completeness.* We begin by discovering *a* relation; we end by discovering *the* relation. Our first achievement is to foretell the *kind*

of phenomenon which will occur under specified conditions; our last achievement is to foretell not only the kind but the *amount*. Or, to reduce the proposition to its most definite form—undeveloped science is *qualitative* prevision; developed science is *quantitative* prevision.

This will at once be perceived to express the remaining distinction between the lower and the higher stages of positive knowledge. The prediction that a piece of lead will take more force to lift it than a piece of wood of equal size, exhibits certainty, but not completeness, of foresight. The kind of effect in which the one body will exceed the other is foreseen; but not the amount by which it will exceed. There is qualitative prevision only. On the other hand, the predictions that at a stated time two particular planets will be in conjunction; that by means of a lever having arms in a given ratio, a known force will raise just so many pounds; that to decompose a given quantity of sulphate of iron by carbonate of soda will require so many grains—these predictions show foreknowledge, not only of the nature of the effects to be produced, but of the magnitude, either of the effects themselves, of the agencies producing them, or of the distance in time or space at which they will be produced. There is both qualitative prevision and quantitative prevision. And this is the unexpressed difference which leads us to consider certain orders of knowledge as especially scientific when contrasted with knowledge in general. Are the phenomena *measurable?* is the test which we unconsciously employ. Space is measurable: hence Geometry. Force and space are measurable: hence Statics. Time, force, and space are measurable: hence Dynamics. The invention of the barometer enabled men to extend the principles of mechanics to the atmosphere; and Aerostatics existed. When a thermometer was devised there arose a science of heat, which was before impossible. Of such external agents as we have found no measures but our sensations

we have no sciences. We have no science of smells; nor have we one of tastes. We have a science of the relations of sounds differing in pitch, because we have discovered a way to measure these relations; but we have no science of sounds in respect to their loudness or their *timbre*, because we have got no measures of loudness and *timbre*. Obviously it is this reduction of the sensible phenomena it presents, to relations of magnitude, which gives to any division of knowledge its specially scientific character. Originally men's knowledge of weights and forces was like their present knowledge of smells and tastes —a knowledge not extending beyond that given by the unaided sensations; and it remained so until weighing instruments and dynamometers were invented. Before there were hour-glasses and clepsydras, most phenomena could be estimated as to their durations and intervals, with no greater precision than degrees of hardness can be estimated by the fingers. Until a thermometric scale was contrived, men's judgments respecting relative amounts of heat stood on the same footing with their present judgments respecting relative amounts of sound. And as in these initial stages, with no aids to observation, only the roughest comparisons of cases could be made, and only the most marked differences perceived, it resulted that only the most simple laws of dependence could be ascertained—only those laws which, being uncomplicated with others, and not disturbed in their manifestations, required no niceties of observation to disentangle them. Whence it appears not only that in proportion as knowledge becomes quantitative do its previsions become complete as well as certain, but that until its assumption of a quantitative character it is necessarily confined to the most elementary relations.

Moreover it is to be remarked that while, on the one hand, we can discover the laws of the greater part of phenomena only by investigating them quantitatively; on the other hand we can extend the range of our quantitative

previsions only as fast as we detect the laws of the results we predict. For clearly the ability to specify the magnitude of a result inaccessible to direct measurement, implies knowledge of its mode of dependence on something which can be measured—implies that we know the particular fact dealt with to be an instance of some more general fact. Thus the extent to which our quantitative previsions have been carried in any direction, indicates the depth to which our knowledge reaches in that direction. And here, as another aspect of the same fact, it may be observed that as we pass from qualitative to quantitative prevision, we pass from inductive science to deductive science. Science while purely inductive is purely qualitative; when inaccurately quantitative it usually consists of part induction, part deduction; and it becomes accurately quantitative only when wholly deductive. We do not mean that the deductive and the quantitative are coextensive; for there is manifestly much deduction that is qualitative only. We mean that all quantitative prevision is reached deductively; and that induction can achieve only qualitative prevision.

Still, however, it must not be supposed that these distinctions enable us to separate ordinary knowledge from science; much as they seem to do so. While they show in what consists the broad contrast between the extreme forms of the two, they yet lead us to recognize their essential identity, and once more prove the difference to be one of degree only. For, on the one hand, much of our common knowledge is to some extent quantitative; seeing that the amount of the foreseen result is known within certain wide limits. And, on the other hand, the highest quantitative prevision does not reach the exact truth, but only a near approach to it. Without clocks the savage knows that the day is longer in the summer than in the winter; without scales he knows that stone is heavier than flesh; that is, he can foresee respecting certain results that their amounts will exceed these, and be less than those

—he knows *about* what they will be. And, with his most delicate instruments and most elaborate calculations, all that the man of science can do, is to reduce the difference between the foreseen and the actual results to an unimportant quantity. Moreover, it must be borne in mind not only that all the sciences are qualitative in their first stages,—not only that some of them, as Chemistry, have but lately reached the quantitative stage—but that the most advanced sciences have attained to their present power of determining quantities not present to the senses, or not directly measurable, by a slow process of improvement extending through thousands of years. So that science and the knowledge of the uncultured are alike in the nature of their previsions, widely as they differ in range; they possess a common imperfection, though this is immensely greater in the last than in the first; and the transition from the one to the other has been through a series of steps by which the imperfection has been rendered continually less, and the range continually wider.

These facts, that science and ordinary knowledge are allied in nature, and that the one is but a perfected and extended form of the other, must necessarily underlie the whole theory of science, its progress, and the relations of its parts to each other. There must be incompleteness in any history of the sciences, which, leaving out of view the first steps of their genesis, commences with them only when they assume definite forms. There must be grave defects, if not a general untruth, in a philosophy of the sciences considered in their interdependence and development, which neglects the inquiry how they came to be distinct sciences, and how they were severally evolved out of the chaos of primitive ideas. Not only a direct consideration of the matter, but all analogy, goes to show that in the earlier and simpler stages must be sought the key to all subsequent intricacies. The time was when the anatomy and physiology of the human being were studied

by themselves—when the adult man was analyzed and the relations of parts and of functions investigated, without reference either to the relations exhibited in the embryo or to the homologous relations existing in other creatures. Now, however, it has become manifest that no true conceptions are possible under such conditions. Anatomists and physiologists find that the real natures of organs and tissues can be ascertained only by tracing their early evolution; and that the affinities between existing genera can be satisfactorily made out only by examining the fossil genera to which they are akin. Well, is it not clear that the like must be true concerning all things that undergo development? Is not science a growth? Has not science, too, its embryology? And must not the neglect of its embryology lead to a misunderstanding of the principles of its evolution and of its existing organization?

There are *à priori* reasons, therefore, for doubting the truth of all philosophies of the sciences which tacitly proceed upon the common notion that scientific knowledge and ordinary knowledge are separate; instead of commencing, as they should, by affiliating the one upon the other, and showing how it gradually came to be distinguishable from the other. We may expect to find their generalizations essentially artificial; and we shall not be deceived. Some illustrations of this may here be fitly introduced, by way of preliminary to a brief sketch of the genesis of science from the point of view indicated. And we cannot more readily find such illustrations than by glancing at a few of the various *classifications* of the sciences that have from time to time been proposed. To consider all of them would take too much space: we must content ourselves with some of the latest.

Commencing with those which may be soonest disposed of, let us notice, first, the arrangement propounded by Oken. An abstract of it runs thus:—

Part I. MATHESIS.—*Pneumatogeny*: Primary Act, Primary Consciousness,

God, Primary Rest, Time, Polarity, Motion, Man, Space, Point, Line, Surface, Globe, Rotation.—*Hylogeny:* Gravity, Matter, Ether, Heavenly Bodies, Light, Heat, Fire.

(He explains that MATHESIS is the doctrine of the whole; *Pneumatogeny* being the doctrine of immaterial totalities, and *Hylogeny* that of material totalities.)

Part II. ONTOLOGY.—*Cosmogeny:* Rest, Centre, Motion, Line, Planets, Form, Planetary System, Comets.—*Stöchiogeny:* Condensation, Simple Matter, Elements, Air, Water, Earth.—*Stöchiology:* Functions of the Elements, &c. &c.—*Kingdoms of Nature:* Individuals.

(He says in explanation that 'ONTOLOGY teaches us the phenomena of matter. The first of these are the heavenly bodies comprehended by *Cosmogeny*. These divide into elements.—*Stöchiogeny*. The earth element divides into minerals—*Mineralogy*. These unite into one collective body—*Geogeny*. The whole in singulars is the living, or *Organic*, which again divides into plants and animals. *Biology*, therefore, divides into *Organogeny, Phytosophy, Zoosophy*.')

FIRST KINGDOM.—MINERALS. *Mineralogy, Geology.*

Part III. BIOLOGY.—*Organosophy, Phytogeny, Phyto-physiology, Phytology, Zoogeny, Physiology, Zoology, Psychology.*

A glance over this confused scheme shows that it is an attempt to classify knowledge, not after the order in which it has been, or may be, built up in the human consciousness; but after an assumed order of creation. It is a pseudo-scientific cosmogony, akin to those which men have enunciated from the earliest times downwards; and only a little more respectable. As such it will not be thought worthy of much consideration by those who, like ourselves, hold that experience is the sole origin of knowledge. Otherwise, it might have been needful to dwell on the incongruities of the arrangement—to ask how motion can be treated of before space? how there can be rotation without matter to rotate? how polarity can be dealt with without involving points and lines? But it will serve our present purpose just to indicate a few of the absurdities resulting from the doctrine which Oken seems to hold in common with Hegel, that "to philosophize on Nature is to re-think the great thought of Creation." Here is a sample:—

"Mathematics is the universal science; so also is

Physio-philosophy, although it is only a part, or rather but a condition of the universe; both are one, or mutually congruent.

"Mathematics is, however, a science of mere forms without substance. Physio-philosophy is, therefore, *mathematics endowed with substance.*"

From the English point of view it is sufficiently amusing to find such a dogma not only gravely stated, but stated as an unquestionable truth. Here we see the experiences of quantitative relations which men have gathered from surrounding bodies and generalized (experiences which had been scarcely at all generalized at the beginning of the historic period)—we find these generalized experiences, these intellectual abstractions, elevated into concrete actualities, projected back into Nature, and considered as the internal frame-work of things—the skeleton by which matter is sustained. But this new form of the old realism, is by no means the most startling of the physio-philosophic principles. We presently read that,

"The highest mathematical idea, or the fundamental principle of all mathematics is the zero = 0." * * *

"Zero is in itself nothing. Mathematics is based upon nothing, and, *consequently*, arises out of nothing.

"Out of nothing, *therefore*, it is possible for something to arise; for mathematics, consisting of propositions, is a something in relation to 0."

By such "consequentlys" and "therefores" it is, that men philosophize when they "re-think the great thought of creation." By dogmas that pretend to be reasons, nothing is made to generate mathematics; and by clothing mathematics with matter, we have the universe! If now we deny, as we *do* deny, that the highest mathematical idea is the zero—if, on the other hand, we assert, as we *do* assert, that the fundamental idea underlying all mathematics, is that of equality; the whole of Oken's cosmogony disappears. And here, indeed, we may see illustrated, the distinctive peculiarity of the German method of procedure in these

matters—the bastard *à priori* method, as it may be termed. The legitimate *à priori* method sets out with propositions of which the negation is inconceivable; the *à priori* method as illegitimately applied, sets out either with propositions of which the negation is *not* inconceivable, or with propositions like Oken's, of which the *affirmation* is inconceivable.

It is needless to proceed further with the analysis; else might we detail the steps by which Oken arrives at the conclusions that "the planets are coagulated colours, for they are coagulated light"; that "the sphere is the expanded nothing;" that gravity is "a weighty nothing, a heavy essence, striving towards a centre;" that "the earth is the identical, water the indifferent, air the different; or the first the centre, the second the radius, the last the periphery of the general globe or of fire." To comment on them would be nearly as absurd as are the propositions themselves. Let us pass on to another of the German systems of knowledge—that of Hegel.

The simple fact that Hegel puts Jacob Bœhme on a par with Bacon, suffices alone to show that his stand-point is far remote from the one usually regarded as scientific: so far remote, indeed, that it is not easy to find any common basis on which to found a criticism. Those who hold that the mind is moulded into conformity with surrounding things by the agency of surrounding things, are necessarily at a loss how to deal with those who, like Schelling and Hegel, assert that surrounding things are solidified mind—that Nature is "petrified intelligence." However, let us briefly glance at Hegel's classification. He divides philosophy into three parts:—

1. *Logic*, or the science of the idea in itself, the pure idea.

2. *The Philosophy of Nature*, or the science of the idea considered under its other form—of the idea as Nature.

3. *The Philosophy of the Mind*, or the science of the idea in its return to itself.

Of these, the second is divided into the natural sciences,

commonly so-called; so that in its more detailed form the series runs thus:—Logic, Mechanics, Physics, Organic Physics, Psychology.

Now, if we believe with Hegel, first, that thought is the true essence of man; second, that thought is the essence of the world; and that, therefore, there is nothing but thought; his classification, beginning with the science of pure thought, may be acceptable. But otherwise, it is an obvious objection to his arrangement, that thought implies things thought of—that there can be no logical forms without the substance of experience—that the science of ideas and the science of things must have a simultaneous origin. Hegel, however, anticipates this objection, and, in his obstinate idealism, replies, that the contrary is true. He affirms that all contained in the forms, to become something, requires to be thought; and that logical forms are the foundations of all things.

It is not surprising that, starting from such premises, and reasoning after this fashion, Hegel finds his way to strange conclusions. Out of *space* and *time* he proceeds to build up *motion, matter, repulsion, attraction, weight,* and *inertia.* He then goes on to logically evolve the solar system. In doing this he widely diverges from the Newtonian theory; reaches by syllogism the conviction that the planets are the most perfect celestial bodies; and, not being able to bring the stars within his theory, says that they are mere formal existences and not living matter, and that as compared with the solar system they are as little admirable as a cutaneous eruption or a swarm of flies.* Results so absurd might be left as self-disproved, were it not that speculators of this class are not alarmed by any amount of incongruity with established beliefs. The only efficient mode of treating systems like this of

* It is curious that the author of "The Plurality of Worlds," with quite other aims, should have persuaded himself into similar conclusions.

Hegel, is to show that they are self-destructive—that by their first steps they ignore that authority on which all their subsequent steps depend. If Hegel professes, as he manifestly does, to develop his scheme by reasoning—if he presents successive inferences as *necessarily following* from certain premises; he implies the postulate that a belief which necessarily follows after certain antecedents is a true belief; and did an opponent reply to one of his inferences that, though it was impossible to think the opposite, yet the opposite was true, he would consider the reply irrational. The procedure, however, which he would thus condemn as destructive of all thinking whatever, is just the procedure exhibited in the enunciation of his own first principles. Mankind find themselves unable to conceive that there can be thought without things thought of. Hegel, however, asserts that there *can* be thought without things thought of. That ultimate test of a true proposition —the inability of the human mind to conceive the negation of it—which in all the successive steps of his arguments he considers valid, he considers invalid where it suits his convenience to do so; and yet at the same time denies the right of an opponent to follow his example. If it is competent for him to posit dogmas which are the direct negations of what human consciousness recognizes; then is it also competent for his antagonists to stop him at any moment by saying, that though the particular inference he is drawing seems to his mind, and to all minds, necessarily to follow from the premises, yet it is not true, but the contrary inference is true. Or, to state the dilemma in another form:—If he sets out with inconceivable propositions, then may he with equal propriety make all his succeeding propositions inconceivable ones—may at every step throughout his reasoning draw the opposite conclusion to that which seems involved.

Hegel's mode of procedure being thus essentially suicidal, the Hegelian classification which depends upon

it, falls to the ground. Let us consider next that of M. Comte.

As all his readers must admit, M. Comte presents us with a scheme of the sciences which, unlike the foregoing ones, demands respectful consideration. Widely as we differ from him, we cheerfully bear witness to the largeness of his views, the clearness of his reasoning, and the value of his speculations as contributing to intellectual progress. Did we believe a serial arrangement of the sciences to be possible, that of M. Comte would certainly be the one we should adopt. His fundamental propositions are thoroughly intelligible; and, if not true, have a great semblance of truth. His successive steps are logically co-ordinated; and he supports his conclusions by a considerable amount of evidence—evidence which, so long as it is not critically examined, or not met by counter evidence, seems to substantiate his positions. But it only needs to assume that antagonistic attitude which *ought* to be assumed towards new doctrines, in the belief that, if true, they will prosper by conquering objectors—it needs but to test his leading doctrines either by other facts than those he cites, or by his own facts differently applied, to show that they will not stand. We will proceed thus to deal with the general principle on which he bases his hierarchy of the sciences.

In the condensed translation of the *Positive Philosophy*, by Miss Martineau, M. Comte says:—"Our problem is, then, to find the one *rational* order, amongst a host of possible systems." . . "This order is determined by the degree of simplicity, or, what comes to the same thing, of generality of their phenomena." And the arrangement he deduces runs thus:—*Mathematics, Astronomy, Physics, Chemistry, Physiology, Social Physics.* This he asserts to be "the true *filiation* of the sciences." He asserts further, that the principle of progression from a greater to a less degree of generality, "which gives this order to the whole body of science, arranges the parts of each science." And

finally, he asserts that the gradations thus established *à priori* among the sciences and the parts of each science, "is in essential conformity with the order which has spontaneously taken place among the branches of natural philosophy;" or, in other words—corresponds with the order of historic development.

Let us compare these assertions with the facts. That there may be perfect fairness, let us make no choice, but take as the field for our comparison, the succeeding section treating of the first science—Mathematics; and let us use none but M. Comte's own facts, and his own admissions. Confining ourselves to this one science, we are limited to comparisons between its several parts. M. Comte says, that the parts of each science must be arranged in the order of their decreasing generality; and that this order of decreasing generality agrees with the order of historic development. Our inquiry will be, then, whether the history of mathematics confirms this statement.

Carrying out his principle, M. Comte divides Mathematics into "Abstract Mathematics, or the Calculus (taking the word in its most extended sense) and Concrete Mathematics, which is composed of General Geometry and of Rational Mechanics." The subject-matter of the first of these is *number;* the subject-matter of the second includes *space, time, motion, force.* The one possesses the highest possible degree of generality; for all things whatever admit of enumeration. The others are less general; seeing that there are endless phenomena that are not cognizable either by general geometry or rational mechanics. In conformity with the alleged law, therefore, the evolution of the calculus must throughout have preceded the evolution of the concrete sub-sciences. Now somewhat awkwardly for him, the first remark M. Comte makes bearing on this point is, that "from an historical point of view, mathematical analysis *appears to have arisen out of* the contemplation of geometrical and mechanical facts." True, he goes

on to say that, "it is not the less independent of these sciences logically speaking;" for that "analytical ideas are, above all others, universal, abstract, and simple; and geometrical conceptions are necessarily founded on them." We will not take advantage of this last passage to charge M. Comte with teaching, after the fashion of Hegel, that there can be thought without things thought of. We are content simply to compare the assertion, that analysis arose out of the contemplation of geometrical and mechanical facts, with the assertion that geometrical conceptions are founded upon analytical ones. Literally interpreted they exactly cancel each other. Interpreted, however, in a liberal sense, they imply, what we believe to be demonstrable, that the two had *a simultaneous origin*. The passage is either nonsense, or it is an admission that abstract and concrete mathematics are coeval. Thus, at the very first step, the alleged congruity between the order of generality and the order of evolution, does not hold good.

But may it not be that though abstract and concrete mathematics took their rise at the same time, the one afterwards developed more rapidly than the other; and has ever since remained in advance of it? No: and again we call M. Comte himself as witness. Fortunately for his argument he has said nothing respecting the early stages of the concrete and abstract divisions after their divergence from a common root; otherwise the advent of Algebra long after the Greek geometry had reached a high development, would have been an inconvenient fact for him to deal with. But passing over this, and limiting ourselves to his own statements, we find, at the opening of the next chapter, the admission, that "the historical development of the abstract portion of mathematical science has, since the time of Descartes, been for the most part *determined* by that of the concrete." Further on we read respecting algebraic functions that "most functions were concrete in their origin—even those which are at present the most purely

abstract; and the ancients discovered only through geometrical definitions elementary algebraic properties of functions to which a numerical value was not attached till long afterwards, rendering abstract to us what was concrete to the old geometers." How do these statements tally with his doctrine? Again, having divided the calculus into algebraic and arithmetical, M. Comte admits, as perforce he must, that the algebraic is more general than the arithmetical; yet he will not say that algebra preceded arithmetic in point of time. And again, having divided the calculus of functions into the calculus of direct functions (common algebra) and the calculus of indirect functions (transcendental analysis), he is obliged to speak of this last as possessing a higher generality than the first; yet it is far more modern. Indeed, by implication, M. Comte himself confesses this incongruity; for he says:— "It might seem that the transcendental analysis ought to be studied before the ordinary, as it provides the equations which the other has to resolve. But though the transcendental *is logically independent of the ordinary*, it is best to follow the usual method of study, taking the ordinary first." In all these cases, then, as well as at the close of the section where he predicts that mathematicians will in time "create procedures of *a wider generality*," M. Comte makes admissions that are diametrically opposed to the alleged law.

In the succeeding chapters treating of the concrete department of mathematics, we find similar contradictions. M. Comte himself names the geometry of the ancients *special* geometry and that of the moderns *general* geometry. He admits that while "the ancients studied geometry with reference to the *bodies* under notice, or specially; the moderns study it with reference to the *phenomena* to be considered, or generally." He admits that while "the ancients extracted all they could out of one line or surface before passing to another," "the moderns, since Descartes, employ themselves on questions

which relate to any figure whatever." These facts are the reverse of what, according to his theory, they should be. So, too, in mechanics. Before dividing it into statics and dynamics, M. Comte treats of the three laws of *motion*, and is obliged to do so; for statics, the more *general* of the two divisions, though it does not involve motion, is impossible as a science until the laws of motion are ascertained. Yet the laws of motion pertain to dynamics, the more *special* of the divisions. Further on he points out that after Archimedes, who discovered the law of equilibrium of the lever, statics made no progress until the establishment of dynamics enabled us to seek "the conditions of equilibrium through the laws of the composition of forces." And he adds—"At this day *this is the method universally employed.* At the first glance it does not appear the most rational—dynamics being more complicated than statics, and precedence being natural to the simpler. It would, in fact, be more philosophical to refer dynamics to statics, as has since been done." Sundry discoveries are afterwards detailed, showing how completely the development of statics has been achieved by considering its problems dynamically; and before the close of the section M. Comte remarks that "before hydrostatics could be comprehended under statics, it was necessary that the abstract theory of equilibrium should be made so general as to apply directly to fluids as well as solids. This was accomplished when Lagrange supplied, as the basis of the whole of rational mechanics, the single principle of virtual velocities." In which statement we have two facts directly at variance with M. Comte's doctrine;—first, that the simpler science, statics, reached its present development only by the aid of the principle of virtual velocities, which belongs to the more complex science, dynamics; and that this "single principle" underlying all rational mechanics—this *most general form* which includes alike the relations of statical,

hydrostatical, and dynamical forces—was reached so late as the time of Lagrange.

Thus it is *not* true that the historical succession of the divisions of mathematics has corresponded with the order of decreasing generality. It is *not* true that abstract mathematics was evolved antecedently to, and independently of, concrete mathematics. It is *not* true that of the subdivisions of abstract mathematics, the more general came before the more special. And it is *not* true that concrete mathematics, in either of its two sections, began with the most abstract and advanced to the less abstract truths.

It may be well to mention, parenthetically, that, in defending his alleged law of progression from the general to the special, M. Comte somewhere comments upon the two meanings of the word *general*, and the resulting liability to confusion. Without now discussing whether the asserted distinction exists in other cases, it is manifest that it does not exist here. In sundry of the instances above quoted, the endeavours made by M. Comte himself to disguise, or to explain away, the precedence of the special over the general, clearly indicate that the generality spoken of is of the kind meant by his formula. And it needs but a brief consideration of the matter to show that, even did he attempt it, he could not distinguish this generality which, as above proved, frequently comes last, from the generality which he says always comes first. For what is the nature of that mental process by which objects, dimensions, weights, times, and the rest, are found capable of having their relations expressed numerically? It is the formation of certain abstract conceptions of unity, duality, and multiplicity, which are applicable to all things alike. It is the invention of general symbols serving to express the numerical relations of entities, whatever be their special characters. And what is the nature of the mental process by which numbers are found capable of having their relations expressed algebraically? It is the same

It is the formation of certain abstract conceptions of numerical functions which are constant whatever be the magnitudes of the numbers. It is the invention of general symbols serving to express the relations between numbers, as numbers express the relations between things. Just as arithmetic deals with the common properties of lines, areas, bulks, forces, periods; so does algebra deal with the common properties of the numbers which arithmetic presents.

Having shown that M. Comte's alleged law of progression does not hold among the several parts of the same science, let us see how it agrees with the facts when applied to the separate sciences. "Astronomy," says M. Comte (*Positive Philosophy*, Book III.), "was a positive science, in its geometrical aspect, from the earliest days of the school of Alexandria; but Physics, which we are now to consider, had no positive character at all till Galileo made his great discoveries on the fall of heavy bodies." On this, our comment is simply that it is a misrepresentation based upon an arbitrary misuse of words—a mere verbal artifice. By choosing to exclude from terrestrial physics those laws of magnitude, motion, and position, which he includes in celestial physics, M. Comte makes it appear that the last owes nothing to the first. Not only is this unwarrantable, but it is radically inconsistent with his own scheme of divisions. At the outset he says—and as the point is important we quote from the original—"Pour la *physique inorganique* nous voyons d'abord, en nous conformant toujours à l'ordre de généralité et de dépendance des phénomènes, qu'elle doit être partagée en deux sections distinctes, suivant qu'elle considère les phénomènes généraux de l'univers, ou, en particulier, ceux que présentent les corps terrestres. D'où la physique céleste, ou l'astronomie, soit géométrique, soit mechanique; et la physique terrestre." Here then we have *inorganic physics* clearly divided into *celestial physics* and *terrestrial physics*—the phenomena presented by the universe, and the pheno-

mena presented by earthly bodies. If now celestial bodies and terrestrial bodies exhibit sundry leading phenomena in common, as they do, how can the generalization of these common phenomena be considered as pertaining to the one class rather than to the other? If inorganic physics includes geometry (which M. Comte has made it do by comprehending *geometrical* astronomy in its sub-section, celestial physics); and if its other sub-section, terrestrial physics, treats of things having geometrical properties; how can the laws of geometrical relations be excluded from terrestrial physics? Clearly if celestial physics includes the geometry of objects in the heavens, terrestrial physics includes the geometry of objects on the earth. And if terrestrial physics includes terrestrial geometry, while celestial physics includes celestial geometry, then the geometrical part of terrestrial physics precedes the geometrical part of celestial physics; seeing that geometry gained its first ideas from surrounding objects. Until men had learnt geometrical relations from bodies on the earth, it was impossible for them to understand the geometrical relations of bodies in the heavens. So, too, with celestial mechanics, which had terrestrial mechanics for its parent. The very conception of *force*, which underlies the whole of mechanical astronomy, is borrowed from our earthly experiences; and the leading laws of mechanical action as exhibited in scales, levers, projectiles, &c., had to be ascertained before the dynamics of the Solar System could be entered upon. What were the laws made use of by Newton in working out his grand discovery? The law of falling bodies disclosed by Galileo; that of the composition of forces also disclosed by Galileo; and that of centrifugal force found out by Huyghens—all of them generalizations of terrestrial physics. Yet, with facts like these before him, M. Comte places astronomy before physics in order of evolution! He does not compare the geometrical parts of the two together, and the mechanical parts of the two

together; for this would by no means suit his hypothesis. But he compares the geometrical part of the one with the mechanical part of the other, and so gives a semblance of truth to his position. He is led away by a verbal illusion. Had he confined his attention to the things and disregarded the words, he would have seen that before mankind scientifically co-ordinated *any one class of phenomena* displayed in the heavens, they had previously co-ordinated *a parallel class of phenomena* displayed on the surface of the earth.

Were it needful we could fill a score pages with the incongruities of M. Comte's scheme. But the foregoing samples will suffice. So far is his law of evolution of the sciences from being tenable, that, by following his example, and arbitrarily ignoring one class of facts, it would be possible to present, with great plausibility, just the opposite generalization to that which he enunciates. While he asserts that the rational order of the sciences, like the order of their historic development, "is determined by the degree of simplicity, or, what comes to the same thing, of generality of their phenomena;" it might contrariwise be asserted that, commencing with the complex and the special, mankind have progressed step by step to a knowledge of greater simplicity and wider generality. So much evidence is there of this as to have drawn from Whewell, in his *History of the Inductive Sciences*, the remark that "the reader has already seen repeatedly in the course of this history, complex and derivative principles presenting themselves to men's minds before simple and elementary ones." Even from M. Comte's own work, numerous facts, admissions, and arguments, might be picked out, tending to show this. We have already quoted his words in proof that both abstract and concrete mathematics have progressed towards a higher degree of generality, and that he looks forward to a higher generality still. Just to strengthen this adverse hypothesis, let us take a further instance.

From the *particular* case of the scales, the law of equilibrium of which was familiar to the earliest nations known, Archimedes advanced to the more *general* case of the lever of which the arms may or may not be equal; the law of equilibrium of which *includes* that of the scales. By the help of Galileo's discovery concerning the composition of forces, D'Alembert "established, for the first time, the equations of equilibrium of *any* system of forces applied to the different points of a solid body"—equations which include all cases of levers and an infinity of cases besides. Clearly this is progress towards a higher generality—towards a knowledge more independent of special circumstances—towards a study of phenomena "the most disengaged from the incidents of particular cases;" which is M. Comte's definition of "the most simple phenomena." Does it not indeed follow from the admitted fact, that mental advance is from the concrete to the abstract, from the particular to the general, that the universal and therefore most simple truths are the last to be discovered? Should we ever succeed in reducing all orders of phenomena to some single law—say of atomic action, as M. Comte suggests—must not that law answer to his test of being *independent* of all others, and therefore most simple? And would not such a law generalize the phenomena of gravity, cohesion, atomic affinity, and electric repulsion, just as the laws of number generalize the quantitative phenomena of space, time and force?

The possibility of saying so much in support of an hypothesis the very reverse of M. Comte's, at once proves that his generalization is only a half-truth. The fact is that neither proposition is correct by itself; and the actuality is expressed only by putting the two together. The progress of science is duplex. It is at once from the special to the general, and from the general to the special. It is analytical and synthetical at the same time.

M. Comte himself observes that the evolution of science

has been accomplished by the division of labour; but he quite misstates the mode in which this division of labour has operated. As he describes it, it has been simply an arrangement of phenomena into classes, and the study of each class by itself. He does not recognize the effect of progress in each class upon *all* other classes: he recognizes only the effect on the class succeeding it in his hierarchical scale. Or if he occasionally admits collateral influences and intercommunications, he does it so grudgingly, and so quickly puts the admissions out of sight and forgets them, as to leave the impression that, with but trifling exceptions, the sciences aid one another only in the order of their alleged succession. The fact is, however, that the division of labour in science, like the division of labour in society, and like the "physiological division of labour" in individual organisms, has been not only a specialization of functions, but a continuous helping of each division by all the others, and of all by each. Every particular class of inquirers has, as it were, secreted its own particular order of truths from the general mass of material which observation accumulates; and all other classes of inquirers have made use of these truths as fast as they were elaborated, with the effect of enabling them the better to elaborate each its own order of truths. It was thus in sundry of the cases we have quoted as at variance with M. Comte's doctrine. It was thus with the application of Huyghens's optical discovery to astronomical observation by Galileo. It was thus with the application of the isochronism of the pendulum to the making of instruments for measuring intervals, astronomical and other. It was thus when the discovery that the refraction and dispersion of light did not follow the same law of variation, affected both astronomy and physiology by giving us achromatic telescopes and microscopes. It was thus when Bradley's discovery of the aberration of light enabled him to make the first step towards ascertaining the motions of the stars.

It was thus when Cavendish's torsion-balance experiment determined the specific gravity of the Earth, and so gave a datum for calculating the specific gravities of the Sun and Planets. It was thus when tables of atmospheric refraction enabled observers to write down the real places of the heavenly bodies instead of their apparent places. It was thus when the discovery of the different expansibilities of metals by heat, gave us the means of correcting our chronometrical measurements of astronomical periods. It was thus when the lines of the prismatic spectrum were used to distinguish the heavenly bodies that are of like nature with the sun from those which are not. It was thus when, as recently, an electro-telegraphic instrument was invented for the more accurate registration of meridional transits. It was thus when the difference in the rates of a clock at the equator, and nearer the poles, gave data for calculating the oblateness of the earth, and accounting for the precession of the equinoxes. It was thus—but it is needless to continue. Here, within our own limited knowledge of its history, we have named ten additional cases in which the single science of astronomy has owed its advance to sciences coming *after* it in M. Comte's series. Not only its minor changes, but its greatest revolutions have been thus determined. Kepler could not have discovered his celebrated laws had it not been for Tycho Brahe's accurate observations; and it was only after some progress in physical and chemical science that the improved instruments with which those observations were made, became possible. The heliocentric theory of the Solar System had to wait until the invention of the telescope before it could be finally established. Nay, even the grand discovery of all—the law of gravitation—depended for its proof upon an operation of physical science, the measurement of a degree on the Earth's surface. So completely, indeed, did it thus depend, that Newton *had actually abandoned his hypothesis* because the

length of a degree, as then stated, brought out wrong results; and it was only after Picart's more exact measurement was published, that he returned to his calculations and proved his great generalization. Now this constant intercommunion which, for brevity's sake, we have illustrated in the case of one science only, has been taking place with all the sciences. Throughout the whole course of their evolution there has been a continuous *consensus* of the sciences—a *consensus* exhibiting a general correspondence with the *consensus* of the faculties in each phase of mental development; the one being an objective registry of the subjective state of the other.

From our present point of view, then, it becomes obvious that the conception of a *serial* arrangement of the sciences is a vicious one. It is not simply that, as M. Comte admits, such a classification "will always involve something, if not arbitrary, at least artificial;" it is not, as he would have us believe, that, neglecting minor imperfections such a classification may be substantially true; but it is that any grouping of the sciences in a succession gives a radically erroneous idea of their genesis and their dependencies. There is no "one *rational* order among a host of possible systems." There is no "true *filiation* of the sciences." The whole hypothesis is fundamentally false. Indeed, it needs but a glance at its origin to see at once how baseless it is. Why a *series*? What reason have we to suppose that the sciences admit of a *linear* arrangement? Where is our warrant for assuming that there is some *succession* in which they can be placed? There is no reason; no warrant. Whence then has arisen the supposition? To use M. Comte's own phraseology, we should say, it is a metaphysical conception. It adds another to the cases constantly occurring, of the human mind being made the measure of Nature. We are obliged to think in sequence; it is a law of our minds that we must consider subjects separately, one after another: *therefore*

Nature must be serial—*therefore* the sciences must be classifiable in a succession. See here the birth of the notion, and the sole evidence of its truth. Men have been obliged when arranging in books their schemes of education and systems of knowledge, to choose *some* order or other. And from inquiring what is the best order, have fallen into the belief that there is an order which truly represents the facts —have persevered in seeking such an order; quite overlooking the previous question whether it is likely that Nature has consulted the convenience of book-making. For German philosophers, who hold that Nature is "petrified intelligence," and that logical forms are the foundations of all things, it is a consistent hypothesis that as thought is serial, Nature is serial; but that M. Comte, who is so bitter an opponent of all anthropomorphism, even in its most evanescent shapes, should have committed the mistake of imposing upon the external world an arrangement which so obviously springs from a limitation of the human consciousness, is somewhat strange. And it is the more strange when we call to mind how, at the outset, M. Comte remarks that in the beginning "*toutes les sciences sont cultivées simultanément par les mêmes esprits;*" that this is "*inevitable et même indispensable;*" and how he further remarks that the different sciences are "*comme les diverses branches d'un tronc unique.*" Were it not accounted for by the distorting influence of a cherished hypothesis, it would be scarcely possible to understand how, after recognizing truths like these, M. Comte should have persisted in attempting to construct "*une échelle encyclopédique.*"

The metaphor which M. Comte has here so inconsistently used to express the relations of the sciences—branches of one trunk—is an approximation to the truth, though not the truth itself. It suggests the facts that the sciences had a common origin; that they have been developing simultaneously; and that they have been from time to time dividing and sub-dividing. But it fails to suggest the fact, that the

divisions and sub-divisions thus arising do not remain separate, but now and again re-unite in direct and indirect ways. They inosculate; they severally send off and receive connecting growths; and the intercommunion has been ever becoming more frequent, more intricate, more widely ramified. There has all along been higher specialization, that there might be a larger generalization; and a deeper analysis, that there might be a better synthesis. Each larger generalization has lifted sundry specializations still higher; and each better synthesis has prepared the way for still deeper analysis.

And here we may fitly enter upon the task awhile since indicated—a sketch of the Genesis of Science, regarded as a gradual outgrowth from common knowledge—an extension of the perceptions by the aid of the reason. We propose to treat it as a psychological process historically displayed; tracing at the same time the advance from qualitative to quantitative prevision; the progress from concrete facts to abstract facts, and the application of such abstract facts to the analysis of new orders of concrete facts; the simultaneous advance in generalization and specialization; the continually increasing subdivision and reunion of the sciences; and their constantly improving *consensus*.

To trace out scientific evolution from its deepest roots would, of course, involve a complete analysis of the mind. For as science is a development of that common knowledge acquired by the unaided senses and uncultured reason, so is that common knowledge itself gradually built up out of the simplest perceptions. We must, therefore, begin somewhere abruptly; and the most appropriate stage to take for our point of departure will be the adult mind of the savage.

Commencing thus, without a proper preliminary analysis, we are naturally somewhat at a loss how to present, in a satisfactory manner, those fundamental processes of thought out of which science originates. Perhaps our argument may

be best initiated by the proposition, that all intelligent action whatever depends upon the discerning of distinctions among surrounding things. The condition under which only it is possible for any creature to obtain food and avoid danger, is, that it shall be differently affected by different objects—that it shall be led to act in one way by one object, and in another way by another. In the lower orders of creatures this condition is fulfilled by means of an apparatus which acts automatically. In the higher orders the actions are partly automatic, partly conscious. And in man they are almost wholly conscious. Throughout, however, there must necessarily exist a certain classification of things according to their properties—a classification which is either organically registered in the system, as in the inferior creation, or is formed by conscious experience, as in ourselves. And it may be further remarked, that the extent to which this classification is carried, roughly indicates the height of intelligence—that, while the lowest organisms are able to do little more than discriminate organic from inorganic matter; while the generality of animals carry their classifications no further than to a limited number of plants or creatures serving for food, a limited number of beasts of prey, and a limited number of places and materials; the most degraded of the human race possess a knowledge of the distinctive natures of a great variety of substances, plants, animals, tools, persons, &c.; not only as classes but as individuals.

What now is the mental process by which classification is effected? Manifestly it is a recognition of the *likeness* or *unlikeness* of things, either in respect of their sizes, colours, forms, weights, textures, tastes, &c., or in respect of their modes of action. By some special mark, sound, or motion, the savage identifies a certain four-legged creature he sees, as one that is good for food, and to be caught in a particular way; or as one that is dangerous; and acts accordingly. He has classed together all the creatures that are *alike* in

this particular. And manifestly in choosing the wood out of which to form his bow, the plant with which to poison his arrows, the bone from which to make his fish-hooks, he identifies them through their chief sensible properties as belonging to the general classes, wood, plant, and bone, but distinguishes them as belonging to sub-classes by virtue of certain properties in which they are *unlike* the rest of the general classes they belong to; and so forms genera and species.

And here it becomes manifest that not only is classification carried on by grouping together in the mind things that are *like;* but that classes and sub-classes are formed and arranged according to the *degrees of unlikeness*. Things strongly contrasted are alone distinguished in the lower stages of mental evolution; as may be any day observed in an infant. And gradually as the powers of discrimination increase, the strongly-contrasted classes at first distinguished, come to be each divided into sub-classes, differing from each other less than the classes differ; and these sub-classes are again divided after the same manner. By the continuance of which process, things are gradually arranged into groups, the members of which are less and less *unlike;* ending, finally, in groups whose members differ only as individuals, and not specifically. And thus there tends ultimately to arise the notion of *complete likeness*. For manifestly, it is impossible that groups should continue to be sub-divided in virtue of smaller and smaller differences, without there being a simultaneous approximation to the notion of no *difference*.

Let us next notice that the recognition of likeness and unlikeness, which underlies classification, and out of which continued classification evolves the idea of complete likeness—let us next notice that it also underlies the process of *naming*, and by consequence *language*. For all language consists, at the outset, of symbols which are as *like* to the things symbolized as it is practicable to make them. The

language of signs is a means of conveying ideas by mimicking the actions or peculiarities of the things referred to. Verbal language also, in its first stage, is a mode of suggesting objects or acts by imitating the sounds which the objects make, or with which the acts are accompanied. Originally these two languages were used simultaneously. It needs but to watch the gesticulations with which the savage accompanies his speech—to see a Bushman dramatizing before an audience his mode of catching game —or to note the extreme paucity of words in primitive vocabularies; to infer that in the beginning, attitudes, gestures, and sounds, were all combined to produce as good a *likeness* as possible of the things, animals, persons, or events described; and that as the sounds came to be understood by themselves the gestures fell into disuse: leaving traces, however, in the manners of the more excitable civilized races. But be this as it may, it suffices simply to observe, how many of the words current among barbarous peoples are like the sounds appertaining to the things signified; how many of our own oldest and simplest words have the same peculiarity; how children habitually invent imitative words; and how the sign-language spontaneously formed by deaf mutes is based on imitative actions—to be convinced that the notion of *likeness* is that from which the nomenclature of objects takes its rise. Were there space we might go on to point out how this law of likeness is traceable, not only in the origin but in the development of language; how in primitive tongues the plural is made by a duplication of the singular, which is a multiplication of the word to make it *like* the multiplicity of the things; how the use of metaphor—that prolific source of new words—is a suggesting of ideas which are *like* the ideas to be conveyed in some respect or other; and how, in the copious use of simile, fable, and allegory among uncivilized races, we see that complex conceptions which there is no direct language for, are

rendered, by presenting known conceptions more or less *like* them.

This view is confirmed, and the predominance of this notion of likeness in primitive thought further illustrated, by the fact that our system of presenting ideas to the eye originated after the same fashion. Writing and printing have descended from picture-language. The earliest mode of permanently registering a fact was by depicting it on a skin and afterwards on a wall; that is—by exhibiting something as *like* to the thing to be remembered as it could be made. Gradually as the practice grew habitual and extensive, the most frequently repeated forms became fixed, and presently abbreviated; and, passing through the hieroglyphic and ideographic phases, the symbols lost all apparent relation to the things signified: just as the majority of our spoken words have done.

Observe, again, that the same thing is true respecting the genesis of reasoning. The *likeness* which is perceived to exist between cases, is the essence of all early reasoning and of much of our present reasoning. The savage, having by experience discovered a relation between a certain object and a certain act, infers that the *like* relation will be found in future. And the expressions we use in our arguments—"*analogy* implies," "the cases are not *parallel*," "by *parity* of reasoning," "there is no *similarity*,"—show how constantly the idea of likeness underlies our ratiocinative processes. Still more clearly will this be seen on recognizing the fact that there is a close connexion between reasoning and classification; that the two have a common root; and that neither can go on without the other. For on the one hand, it is a familiar truth that the attributing to a body in consequence of some of its properties, all those other properties in virtue of which it is referred to a particular class, is an act of inference. And, on the other hand, the forming of a generalization is the putting together in one class, all those

cases which present like relations; while the drawing a deduction is essentially the perception that a particular case belongs to a certain class of cases previously generalized. So that as classification is a grouping together of *like things;* reasoning is a grouping together of *like relations* among things. Add to which, that while the perfection gradually achieved in classification consists in the formation of groups of *objects* which are *completely alike;* the perfection gradually achieved in reasoning consists in the formation of groups of *cases* which are *completely alike.*

Once more we may contemplate this dominant idea of likeness as exhibited in art. All art, civilized as well as savage, consists almost wholly in the making of objects *like* other objects; either as found in Nature, or as produced by previous art. If we trace back the varied art-products now existing, we find that at each stage the divergence from previous patterns is but small when compared with the agreement; and in the earliest art the persistency of imitation is yet more conspicuous. The old forms and ornaments and symbols were held sacred, and perpetually copied. Indeed, the strong imitative tendency notoriously displayed by the lowest human races—often seeming to be half automatic, ensures among them a constant reproducing of likenesses of things, forms, signs, sounds, actions and whatever else is imitable; and we may even suspect that this aboriginal peculiarity is in some way connected with the culture and development of this general conception, which we have found so deep and wide-spread in its applications.

And now let us go on to consider how, by a further unfolding of this same fundamental notion, there is a gradual formation of the first germs of science. This idea of likeness which underlies classification, nomenclature, language spoken and written, reasoning, and art; and which plays so important a part because all acts of intelligence are made

possible only by distinguishing among surrounding things, or grouping them into like and unlike;—this idea we shall find to be the one of which science is the especial product. Already during the stage we have been describing, there has existed *qualitative* prevision in respect to the commoner phenomena with which savage life is familiar; and we have now to inquire how the elements of *quantitative* prevision are evolved. We shall find that they originate by the perfecting of this same idea of likeness—that they have their rise in that conception of *complete likeness* which, as we have seen, necessarily results from the continued process of classification.

For when the process of classification has been carried as far as it is possible for the uncivilized to carry it—when the animal kingdom has been grouped not merely into quadrupeds, birds, fishes, and insects, but each of these divided into kinds—when there come to be classes, in each of which the members differ only as individuals, and not specifically; it is clear that there must frequently occur an observation of objects which differ so little as to be indistinguishable. Among several creatures which the savage has killed and carried home, it must often happen that some one, which he wished to identify, is so exactly like another that he cannot tell which is which. Thus, then, there originates the notion of *equality*. The things which among ourselves are called *equal*—whether lines, angles, weights, temperatures, sounds or colours—are things which produce in us sensations which cannot be distinguished from each other. It is true that we now apply the word *equal* chiefly to the separate traits or relations which objects exhibit, and not to those combinations of them constituting our conceptions of the objects; but this limitation of the idea has evidently arisen by analysis. That the notion of equality originated as alleged, will, we think, become obvious on remembering that as there were no artificial objects from which it could have been

abstracted, it must have been abstracted from natural objects; and that the various families of the animal kingdom chiefly furnish those natural objects which display the requisite exactitude of likeness.

The experiences out of which this general idea of equality is evolved, give birth at the same time to a more complex idea of equality; or, rather, the process just described generates an idea of equality which further experience separates into two ideas—*equality of things* and *equality of relations*. While organic forms occasionally exhibit this perfection of likeness out of which the notion of simple equality arises, they more frequently exhibit only that kind of likeness which we call *similarity;* and which is really compound equality. For the similarity of two creatures of the same species but of different sizes, is of the same nature as the similarity of two geometrical figures. In either case, any two parts of the one bear the same ratio to one another, as the homologous parts of the other. Given in a species, the proportions found to exist among the bones, and we may, and zoologists do, predict from any one, the dimensions of the rest; just as, when knowing the proportions subsisting among the parts of a geometrical figure, we may, from the length of one, calculate the others. And if, in the case of similar geometrical figures, the similarity can be established only by proving exactness of proportion among the homologous parts—if we express this relation between two parts in the one, and the corresponding parts in the other, by the formula A is to B as a is to b; if we otherwise write this, A to B = a to b; if, consequently, the fact we prove is that the relation of A to B *equals* the relation of a to b; then it is manifest that the fundamental conception of similarity is *equality of relations*. With this explanation we shall be understood when we say that the notion of equality of relations is the basis of all exact reasoning. Already it has been shown that reasoning in general is a recognition

of *likeness* of relations; and here we further find that while the notion of likeness of things ultimately evolves the idea of simple equality, the notion of likeness of relations evolves the idea of equality of relations: of which the one is the concrete germ of exact science, while the other is its abstract germ. Those who cannot understand how the recognition of similarity in creatures of the same kind, can have any alliance with reasoning, will get over the difficulty on remembering that the phenomena among which equality of relations is thus perceived, are phenomena of the same order and are present to the senses at the same time; while those among which developed reason perceives relations, are generally neither of the same order, nor simultaneously present. And if, further, they will call to mind how Cuvier and Owen, from a single part of a creature, as a tooth, construct the rest by a process of reasoning based on this equality of relations, they will see that the two things are intimately connected, remote as they at first seem. But we anticipate. What it concerns us here to observe is, that from familiarity with organic forms there simultaneously arose the ideas of *simple equality*, and *equality of relations*.

At the same time, too, and out of the same mental processes, came the first distinct ideas of *number*. In the earliest stages, the presentation of several like objects produced merely an indefinite conception of multiplicity; as it still does among Australians, and Bushmen, and Damaras, when the number presented exceeds three or four. With such a fact before us we may safely infer that the first clear numerical conception was that of duality as contrasted with unity. And this notion of duality must necessarily have grown up side by side with those of likeness and equality; seeing that it is impossible to recognize the likeness of two things without also perceiving that there are two. From the very beginning the conception of number must have been, as it is still, associated with

likeness or equality of the things numbered; and for the purposes of calculation, an ideal equality of the things is assumed. Before any *absolutely true* numerical results can be reached, it is requisite that the units be *absolutely equal.* The only way in which we can establish a numerical relationship between things that do not yield us like impressions, is to divide them into parts that *do* yield us like impressions. Two unlike magnitudes of extension, force, time, weight, or what not, can have their relative amounts estimated, only by means of some small unit that is contained many times in both; and even if we finally write down the greater one as a unit and the other as a fraction of it, we state, in the denominator of the fraction, the number of parts into which the unit must be divided to be comparable with the fraction. It is, indeed, true, that by a modern process of abstraction, we occasionally apply numbers to unequal units, as the furniture at a sale or the various animals on a farm, simply as so many separate entities; but no exact quantitative result can be brought out by calculation with units of this order. And, indeed, it is the distinctive peculiarity of the calculus in general, that it proceeds on the hypothesis of that absolute equality of its abstract units, which no real units possess; and that the exactness of its results holds only in virtue of this hypothesis. The first ideas of number must necessarily then have been derived from like or equal magnitudes as seen chiefly in organic objects; and as the like magnitudes most frequently observed were magnitudes of extension, it follows that geometry and arithmetic had a simultaneous origin.

Not only are the first distinct ideas of number co-ordinate with ideas of likeness and equality, but the first efforts at numeration display the same relationship. On reading accounts of savage tribes, we find that the method of counting by the fingers, still followed by many children, is the aboriginal method. Neglecting the several cases

in which the ability to enumerate does not reach even to the number of fingers on one hand, there are many cases in which it does not extend beyond ten—the limit of the simple finger notation. The fact that in so many instances, remote, and seemingly unrelated nations, have adopted *ten* as their basic number; together with the fact that in the remaining instances the basic number is either *five* (the fingers of one hand) or *twenty* (the fingers and toes); of themselves show that the fingers were the original units of numeration. The still surviving use of the word *digit*, as the general name for a figure in arithmetic, is significant; and it is even said that our word *ten* (Sax. tyn; Dutch, tien; German, zehn) means in its primitive expanded form *two hands*. So that, originally, to say there were ten things, was to say there were two hands of them. From all which evidence it is tolerably clear that the earliest mode of conveying the idea of a number of things, was by holding up as many fingers as there were things; that is, by using a symbol which was *equal*, in respect of multiplicity, to the group symbolized. For which inference there is, indeed, strong confirmation in the statement that our own soldiers spontaneously adopted this device in their dealings with the Turks during the Crimean war. And here it should be remarked that in this re-combination of the notion of equality with that of multiplicity, by which the first steps in numeration are effected, we may see one of the earliest of those inosculations between the diverging branches of science, which are afterwards of perpetual occurrence.

As this observation suggests, it will be well, before tracing the mode in which exact science emerges from the inexact judgments of the senses, and showing the non-serial evolution of its divisions, to note the non-serial character of those preliminary processes of which all after development is a continuation. On re-considering them it will be seen that not only are they divergent branches

from a common root,—not only are they simultaneous in their growth; but that they are mutual aids; and that none can advance without the rest. That progress of classification for which the unfolding of the perceptions paves the way, is impossible without a corresponding progress in language, by which greater varieties of objects are thinkable and expressible. On the one hand classification cannot be carried far without names by which to designate the classes; and on the other hand language cannot be made faster than things are classified. Again, the multiplication of classes and the consequent narrowing of each class, itself involves a greater likeness among the things classed together; and the consequent approach towards the notion of complete likeness itself allows classification to be carried higher. Moreover, classification necessarily advances *pari passu* with rationality—the classification of *things* with the classification of *relations*. For things that belong to the same class are, by implication, things of which the properties and modes of behaviour—the co-existences and sequences—are more or less the same; and the recognition of this sameness of co-existences and sequences is reasoning. Whence it follows that the advance of classification is necessarily proportionate to the advance of generalizations. Yet further, the notion of *likeness*, both in things and relations, simultaneously evolves by one process of culture the ideas of *equality* of things and *equality* of relations; which are the respective bases of exact concrete reasoning and exact abstract reasoning—Mathematics and Logic. And once more, this idea of equality, in the very process of being formed, necessarily gives origin to two series of relations—those of magnitude and those of number; from which arise geometry and the calculus. Thus the process throughout is one of perpetual subdivision and perpetual intercommunication of the divisions. From the very first there has been that *consensus* of different kinds of knowledge,

answering to the *consensus* of the intellectual faculties, which, as already said, must exist among the sciences.

Let us now go on to observe how, out of the notions of *equality* and *number*, as arrived at in the manner described, there gradually arose the elements of quantitative prevision.

Equality, once having come to be definitely conceived, was recognizable among other phenomena than those of magnitude. Being predicable of all things producing indistinguishable impressions, there naturally grew up ideas of equality in weights, sounds, colours, &c.; and, indeed, it can scarcely be doubted that the occasional experience of equal weights, sounds, and colours, had a share in developing the abstract conception of equality—that the ideas of equality in sizes, relations, forces, resistances, and sensible properties in general, were evolved during the same stage of mental development. But however this may be, it is clear that as fast as the notion of equality gained definiteness, so fast did that lowest kind of quantitative prevision which is achieved without any instrumental aid, become possible. The ability to estimate, however roughly, the amount of a foreseen result, implies the conception that it will be *equal* to a certain imagined quantity; and the correctness of the estimate will manifestly depend on the precision which the perceptions of sensible equality have reached. A savage with a piece of stone in his hand, and another piece lying before him of greater bulk but of the same kind (sameness of kind being inferred from the *equality* of the two in colour and texture) knows about what effort he must put forth to raise this other piece; and he judges accurately in proportion to the accuracy with which he perceives that the one is twice, three times, four times, &c. as large as the other; that is—in proportion to the precision of his ideas of equality and number. And here let us not omit to notice that even in these vaguest of quantitative previsions, the conception of *equality of relations* is also involved. For it is only in

virtue of an undefined consciousness that the relation between bulk and weight in the one stone is *equal* to the relation between bulk and weight in the other, that even the roughest approximation can be made.

But how came the transition from those uncertain perceptions of equality which the unaided senses give, to the certain ones with which science deals? It came by placing the things compared in juxtaposition. Equality being asserted of things which give us indistinguishable impressions, and no distinct comparison of impressions being possible unless they occur in immediate succession, it results that exactness of equality is ascertainable in proportion to the closeness of the compared things. Hence the fact that when we wish to judge of two shades of colour whether they are alike or not, we place them side by side; hence the fact that we cannot, with any precision, say which of two allied sounds is the louder, or the higher in pitch, unless we hear the one immediately after the other; hence the fact that to estimate the ratio of weights, we take one in each hand, that we may compare their pressures by rapidly alternating in thought from the one to the other; hence the fact, that in a piece of music, we can continue to make equal beats when the first beat has been given, but cannot ensure commencing with the same length of beat on a future occasion; and hence, lastly, the fact, that of all magnitudes, those of *linear extension* are those of which the equality is most precisely ascertainable, and those to which, by consequence, all others have to be reduced. For it is the peculiarity of linear extension that it alone allows its magnitudes to be placed in *absolute* juxtaposition, or, rather, in coincident position; it alone can test the equality of two magnitudes by observing whether they will coalesce, as two equal mathematical lines do, when placed between the same points; it alone can test *equality* by trying whether it will become *identity*. Hence, then, the fact, that all exact science is reducible,

by an ultimate analysis, to results measured in equal units of linear extension.

Still it remains to be noticed in what manner this determination of equality by comparison of linear magnitudes originated. Once more may we perceive that surrounding natural objects supplied the needful lessons. From the beginning there must have been a constant experience of like things placed side by side—men standing and walking together; animals from the same herd; fish from the same shoal. And the ceaseless repetition of these experiences could not fail to suggest the observation, that the nearer together any objects were, the more visible became any inequality between them. Hence the obvious device of putting in apposition, things of which it was desired to ascertain the relative magnitudes. Hence the idea of *measure*. And here we suddenly come upon a group of facts which afford a solid basis to the remainder of our argument; while they also furnish strong evidence in support of the foregoing speculations. Those who look sceptically on this attempted rehabilitation of early mental development, and who think that the derivation of so many primary notions from organic forms is somewhat strained, will perhaps see more probability in the hypotheses which have been ventured, on discovering that all measures of *extension* and *force* originated from the lengths and weights of organic bodies, and all measures of *time* from the periodic phenomena of either organic or inorganic bodies.

Thus, among linear measures, the cubit of the Hebrews was the *length of the forearm* from the elbow to the end of the middle finger; and the smaller scriptural dimensions are expressed in *hand-breadths* and *spans*. The Egyptian cubit, which was similarly derived, was divided into digits, which were *finger-breadths*; and each finger-breadth was more definitely expressed as being equal to four *grains of barley* placed breadthwise. Other ancient measures were

the orgyia or *stretch of the arms*, the *pace*, and the *palm*. So persistent has been the use of these natural units of length in the East, that even now some Arabs mete out cloth by the forearm. So, too, is it with European measures. The *foot* prevails as a dimension throughout Europe, and has done so since the time of the Romans, by whom, also, it was used: its lengths in different places varying not much more than men's feet vary. The heights of horses are still expressed in *hands*. The inch is the length of the terminal joint of *the thumb;* as is clearly shown in France, where *pouce* means both thumb and inch. Then we have the inch divided into three *barley-corns*. So completely, indeed, have these organic dimensions served as the substrata of mensuration, that it is only by means of them that we can form any estimate of some of the ancient distances. For example, the length of a degree on the Earth's surface, as determined by the Arabian astronomers shortly after the death of Haroun-al-Raschid, was fifty-six of their miles. We know nothing of their mile further than that it was 4000 cubits; and whether these were sacred cubits or common cubits, would remain doubtful, but that the length of the cubit is given as twenty-seven inches, and each inch defined as the thickness of six barley-grains. Thus one of the earliest measurements of a degree comes down to us in barley-grains. Not only did organic lengths furnish those approximate measures which satisfied men's needs in ruder ages, but they furnished also the standard measures required in later times. One instance occurs in our own history. To remedy the irregularities then prevailing, Henry I. commanded that the ulna, or ancient ell, which answers to the modern yard, should be made of the exact length of *his own arm*.

Measures of weight had a kindred derivation. Seeds seem commonly to have supplied the units. The original of the carat used for weighing in India is *a small bean*. Our own systems, both troy and avoirdupois, are derived

primarily from wheat-corns. Our smallest weight, the grain, is *a grain of wheat*. This is not a speculation; it is an historically-registered fact. Henry III. enacted that an ounce should be the weight of 640 dry grains of wheat from the middle of the ear. And as all the other weights are multiples or sub-multiples of this, it follows that the grain of wheat is the basis of our scale. So natural is it to use organic bodies as weights, before artificial weights have been established, or where they are not to be had, that in some of the remoter parts of Ireland the people are said to be in the habit, even now, of putting a man into the scales to serve as a measure for heavy commodities.

Similarly with time. Astronomical periodicity, and the periodicity of animal and vegetable life, are simultaneously used in the first stages of progress for estimating epochs. The simplest unit of time, the day, nature supplies ready made. The next simplest period, the moneth or month, is also thrust upon men's notice by the conspicuous changes constituting a lunation. For larger divisions than these, the phenomena of the seasons, and the chief events from time to time occurring, have been used by early and uncivilized races. Among the Egyptians the rising of the Nile served as a mark. The New Zealanders were found to begin their year from the reappearance of the Pleiades above the sea. One of the uses ascribed to birds, by the Greeks, was to indicate the seasons by their migrations. Barrow describes the aboriginal Hottentot as expressing dates by the number of moons before or after the ripening of one of his chief articles of food. He further states that the Kaffir chronology is kept by the moon, and is registered by notches on sticks—the death of a favourite chief, or the gaining of a victory, serving for a new era. By which last fact, we are at once reminded that in early history, events are commonly recorded as occurring in certain reigns, and in certain years of certain reigns: a proceeding which made a king's reign

a rude measure of duration. And, as further illustrating the tendency to divide time by natural phenomena and natural events, it may be noticed that even by our own peasantry the definite divisions of months and years are but little used; and that they habitually refer to occurrences as "before sheep-shearing," or "after harvest," or "about the time when the squire died." It is manifest, therefore, that the approximately equal periods perceived in Nature gave the first units of measure for time; as did Nature's approximately equal lengths and weights give the first units of measure for space and force.

It remains only to observe, that measures of value were similarly derived. Barter, in one form or other, is found among all but the very lowest human races. It is obviously based upon the notion of *equality of worth*. And as it gradually merges into trade by the introduction of some kind of currency, we find that the *measures of worth*, constituting this currency, are organic bodies; in some cases *cowries*, in others *cocoa-nuts*, in others *cattle*, in others *pigs*; among the American Indians peltry or *skins*, and in Iceland *dried fish*.

Notions of exact equality and of measure having been reached, there arose definite ideas of magnitudes as being multiples one of another; whence the practice of measurement by direct apposition of a measure. The determination of linear extensions by this process can scarcely be called science, though it is a step towards it; but the determination of lengths of time by an analogous process may be considered as one of the earliest samples of quantitative prevision. For when it is first ascertained that the moon completes the cycle of her changes in about thirty days—a fact known to most uncivilized tribes that can count beyond the number of their fingers—it is manifest that it becomes possible to say in what number of days any specified phase of the moon will recur; and it is also manifest that this prevision is effected by an apposition of two times, after the same manner

that linear space is measured by the apposition of two lines. For to express the moon's period in days, is to say how many of these units of measure are contained in the period to be measured—is to ascertain the distance between two points in time by means of a *scale of days*, just as we ascertain the distance between two points in space by a scale of feet or inches; and in each case the scale coincides with the thing measured—mentally in the one, visibly in the other. So that in this simplest, and perhaps earliest case of quantitative prevision, the phenomena are not only thrust daily upon men's notice, but Nature is, as it were, perpetually repeating that process of measurement by observing which the prevision is effected.

This fact, that in very early stages of social progress it is known that the moon goes through her changes in nearly thirty days, and that in rather more than twelve moons the seasons return—this fact that chronological astronomy assumes a certain scientific character even before geometry does; while it is partly due to the circumstance that the astronomical divisions, day, month, and year, are ready made for us, is partly due to the further circumstances that agricultural and other operations were at first regulated astronomically, and that from the supposed divine nature of the heavenly bodies their motions determined the periodical religious festivals. As instances of the one we have the observation of the Egyptians, that the rising of the Nile corresponded with the heliacal rising of Sirius; the directions given by Hesiod for reaping and ploughing, according to the positions of the Pleiades; and his maxim that "fifty days after the turning of the sun is a seasonable time for beginning a voyage." As instances of the other, we have the naming of the days after the sun, moon, and planets; the early attempts among Eastern nations to regulate the calendar so that the gods might not be offended by the displacement of their sacrifices; and the fixing of the great annual festival of the Peruvians by the position of the sun.

In all which facts we see that, at first, science was simply an appliance of religion and industry.

After the discoveries that a lunation occupies nearly thirty days, and that some twelve lunations occupy a year—discoveries which we may infer were the earliest, from the fact that existing uncivilized races have made them—we come to the first known astronomical records, which are those of eclipses. The Chaldeans were able to predict these. "This they did, probably," says Dr. Whewell in his useful history, from which most of the materials we are about to use will be drawn, "by means of their cycle of 223 months, or about eighteen years; for, at the end of this time, the eclipses of the moon begin to return, at the same intervals and in the same order as at the beginning." Now this method of calculating eclipses by means of a recurring cycle, —the *Saros* as they called it—is a more complex case of prevision by means of coincidence of measures. For by what observations must the Chaldeans have discovered this cycle? Obviously, as Delambre infers, by inspecting their registers; by comparing the successive intervals; by finding that some of the intervals were alike; by seeing that these equal intervals were eighteen years apart; by discovering that *all* the intervals that were eighteen years apart were equal; by ascertaining that the intervals formed a series which repeated itself, so that if one of the cycles of intervals were superposed on another the divisions would fit. And this being once perceived, it became possible to use the cycle as a scale of time by which to measure out future periods of recurrence. Seeing thus that the process of so predicting eclipses, is in essence the same as that of predicting the moon's monthly changes by observing the number of days after which they repeat—seeing that the two differ only in the extent and irregularity of the intervals; it is not difficult to understand how such an amount of knowledge should so early have been reached. And we shall be the less surprised on remembering that the only things involved in these

provisions were *time* and *number*; and that the time was in a manner self-numbered.

Still, the ability to predict events recurring only after so long a period as eighteen years, implies a considerable advance in civilization—a considerable development of general knowledge; and we have now to inquire what progress in other sciences accompanied, and was necessary to, these astronomical previsions. In the first place, there must have been a tolerably efficient system of calculation. Mere finger-counting, mere head-reckoning, even with the aid of a decimal notation, could not have sufficed for numbering the days in a year; much less the years, months, and days between eclipses. Consequently there must have been a mode of registering numbers; probably even a system of numerals. The earliest numerical records, if we may judge by the practices of the less civilized races now existing, were probably kept by notches cut on sticks, or strokes marked on walls; much as public-house scores are kept now. And there is reason to think that the first numerals used were simply groups of straight strokes, as some of the still-extant Roman ones are; leading us to suspect that these groups of strokes were used to represent groups of fingers, as the groups of fingers had been used to represent groups of objects—a supposition harmonizing with the aboriginal practice of picture writing. Be this so or not, however, it is manifest that before the Chaldeans discovered their *Saros*, they must have had both a set of written symbols serving for an extensive numeration, and a familiarity with the simpler rules of arithmetic.

Not only must abstract mathematics have made some progress, but concrete mathematics also. It is scarcely possible that the buildings belonging to this era should have been laid out and erected without any knowledge of geometry. At any rate, there must have existed that elementary geometry which deals with direct measurement

—with the apposition of lines; and it seems that only after the discovery of those simple proceedings, by which right angles are drawn, and relative positions fixed, could so regular an architecture be executed. In the case of the other division of concrete mathematics—mechanics, we have definite evidence of progress. We know that the lever and the inclined plane were employed during this period: implying that there was a qualitative prevision of their effects, if not a quantitative one. But we know more. We read of weights in the earliest records; and we find weights in ruins of the highest antiquity. Weights imply scales, of which we have also mention; and scales involve the primary theorem of mechanics in its least complicated form—involve not a qualitative but a quantitative prevision of mechanical effects. And here we may notice how mechanics, in common with the other exact sciences, took its rise from the simplest application of the idea of *equality*. For the mechanical proposition which the scales involve, is, that if a lever with *equal* arms, have *equal* weights suspended from them, the weights will remain at *equal* altitudes. And we may further notice how, in this first step of rational mechanics, we see illustrated the truth awhile since named, that as magnitudes of linear extension are the only ones of which the equality is exactly ascertainable, the equalities of other magnitudes have at the outset to be determined by means of them. For the equality of the weights which balance each other in scales, depends on the equality of the arms: we can know that the weights are equal only by proving that the arms are equal. And when by this means we have obtained a system of weights,—a set of equal units of force and definite multiples of them, then does a science of mechanics become possible. Whence, indeed, it follows, that rational mechanics could not possibly have any other starting-point than the scales.

Let us further remember that during this same period

there was some knowledge of chemistry. Sundry of the arts which we know to have been carried on, were made possible only by a generalized experience of the modes in which certain bodies affect each other under special conditions. In metallurgy, which was extensively practised, this is abundantly illustrated. And we even have evidence that in some cases the knowledge possessed was, in a sense, quantitative. For, as we find by analysis that the hard alloy of which the Egyptians made their cutting tools, was composed of copper and tin in fixed proportions, there must have been an established prevision that such an alloy was to be obtained only by mixing them in these proportions. It is true, this was but a simple empirical generalization; but so was the generalization respecting the recurrence of eclipses; so are the first generalizations of every science.

Respecting the simultaneous advance of the sciences during this early epoch, it remains to point out that even the most complex of them must have made some progress. For under what conditions only were the foregoing developments possible? The conditions furnished by an established and organized social system. A long continued registry of eclipses; the building of palaces; the use of scales; the practice of metallurgy—alike imply a settled and populous nation. The existence of such a nation not only presupposes laws and some administration of justice, which we know existed, but it presupposes successful laws —laws conforming in some degree to the conditions of social stability—laws enacted because it was found that the actions forbidden by them were dangerous to the State. We do not by any means say that all, or even the greater part, of the laws were of this nature; but we do say, that the fundamental ones were. It cannot be denied that the laws affecting life and property were such. It cannot be denied that, however little these were enforced between class and class, they were to a considerable extent

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enforced between members of the same class. It can scarcely be questioned, that the administration of them between members of the same class was seen by rulers to be necessary for keeping society together. But supposition aside, it is clear that the habitual recognition of these claims in their laws, implied some prevision of social phenomena. That same idea of *equality*, which, as we have seen, underlies other science, underlies also morals and sociology. The conception of justice, which is the primary one in morals; and the administration of justice, which is the vital condition to social existence; are impossible without the recognition of a certain likeness in men's claims, in virtue of their common humanity. *Equity* literally means *equalness;* and if it be admitted that there were even the vaguest ideas of equity in these primitive eras, it must be admitted that there was some appreciation of the equalness of men's liberties to pursue the objects of life—some appreciation, therefore, of the essential principle of national equilibrium.

Thus in this initial stage of the positive sciences, before geometry had yet done more than evolve a few empirical rules—before mechanics had passed beyond its first theorem —before astronomy had advanced from its merely chronological phase into the geometrical; the most involved of the sciences had reached a certain degree of development—a development without which no progress in other sciences was possible.

Only noting as we pass, how, thus early, we may see that the progress of exact science was not only towards an increasing number of previsions, but towards previsions more accurately quantitative—how, in astronomy, the recurring period of the moon's motions was by and by more correctly ascertained to be two hundred and thirty-five lunations; how Callipus further corrected this Metonic cycle, by leaving out a day at the end of every seventy-six years; and how these successive advances implied a

longer continued registry of observations, and the co-ordination of a greater number of facts; let us go on to inquire how geometrical astronomy took its rise. The first astronomical instrument was the gnomon. This was not only early in use in the East, but it was found among the Mexicans; the sole astronomical observations of the Peruvians were made by it; and we read that 1100 B.C., the Chinese observed that, at a certain place, the length of the sun's shadow, at the summer solstice, was to the height of the gnomon, as one and a half to eight. Here again it is observable, both that the instrument is found ready made, and that Nature is perpetually performing the process of measurement. Any fixed, erect object—a column, a pole, the angle of a building—serves for a gnomon; and it needs but to notice the changing position of the shadow it daily throws, to make the first step in geometrical astronomy. How small this first step was, may be seen in the fact that the only things ascertained at the outset were the periods of the summer and winter solstices, which corresponded with the least and greatest lengths of the mid-day shadow; and to fix which, it was needful merely to mark the point to which each day's shadow reached. And now let it not be overlooked that in the observing at what time during the next year this extreme limit of the shadow was again reached, and in the inference that the sun had then arrived at the same turning point in his annual course, we have one of the simplest instances of that combined use of *equal magnitudes* and *equal relations*, by which all exact science, all quantitative prevision, is reached. For the relation observed was between the length of the gnomon's shadow and the sun's position in the heavens; and the inference drawn was that when, next year, the extremity of the shadow came to the same point, he occupied the same place. That is, the ideas involved were, the equality of the shadows, and the equality of the relations between

shadow and sun in successive years. As in the case of the scales, the equality of relations here recognized is of the simplest order. It is not as those habitually dealt with in the higher kinds of scientific reasoning, which answer to the general type—the relation between two and three equals the relation between six and nine; but it follows the type—the relation between two and three equals the relation between two and three: it is a case of not simply *equal* relations, but *coinciding* relations. And here, indeed, we may see beautifully illustrated how the idea of equal relations takes its rise after the same manner that that of equal magnitudes does. As already shown, the idea of equal magnitudes arose from the observed coincidence of two lengths placed together; and in this case we have not only two coincident lengths of shadows, but two coincident relations between sun and shadows.

From the use of the gnomon there naturally grew up the conception of angular measurements; and with the advance of geometrical conceptions came the hemisphere of Berosus, the equinoctial armil, the solstitial armil, and the quadrant of Ptolemy—all of them employing shadows as indices of the sun's position, but in combination with angular divisions. It is out of the question for us here to trace these details of progress. It must suffice to remark that in all of them we may see that notion of equality of relations of a more complex kind, which is best illustrated in the astrolabe, an instrument which consisted "of circular rims, moveable one within the other, or about poles, and contained circles which were to be brought into the position of the ecliptic, and of a plane passing through the sun and the poles of the ecliptic"—an instrument, therefore, which represented, as by a model, the relative positions of certain imaginary lines and planes in the heavens; which was adjusted by putting these representative lines and planes into parallelism with the celestial ones; and which depended for its use on the perception that the relations among these

representative lines and planes were *equal* to the relations among those represented. We might go on to point out how the conception of the heavens as a revolving hollow sphere, the explanation of the moon's phases, and indeed all the successive steps taken, involved this same mental process. But we must content ourselves with referring to the theory of eccentrics and epicycles, as a further marked illustration of it. As first suggested, and as proved by Hipparchus to afford an explanation of the leading irregularities in the celestial motions, this theory involved the perception that the progressions, retrogressions, and variations of velocity seen in the heavenly bodies, might be reconciled with their assumed uniform movements in circles, by supposing that the earth was not in the centre of their orbits; or by supposing that they revolved in circles whose centres revolved round the earth; or by both. The discovery that this would account for the appearances, was the discovery that in certain geometrical diagrams the relations were such, that the uniform motion of points along curves conditioned in specified ways, would, when looked at from a particular position, present analogous irregularities; and the calculations of Hipparchus involved the belief that the relations subsisting among these geometrical curves were *equal* to the relations subsisting among the celestial orbits.

Leaving here these details of astronomical progress, and the philosophy of it, let us observe how the relatively concrete science of geometrical astronomy, having been thus far helped forward by the development of geometry in general, reacted upon geometry, caused it also to advance, and was again assisted by it. Hipparchus, before making his solar and lunar tables, had to discover rules for calculating the relations between the sides and angles of triangles—*trigonometry*, a subdivision of pure mathematics. Further, the reduction of the doctrine of the sphere to a quantitative form needed for astronomical purposes, required the formation of a *spherical trigonometry*, which

was also achieved by Hipparchus. Thus both plane and spherical trigonometry, which are parts of the highly abstract and simple science of extension, remained undeveloped until the less abstract and more complex science of the celestial motions had need of them. The fact admitted by M. Comte, that since Descartes the progress of the abstract division of mathematics has been determined by that of the concrete division, is paralleled by the still more significant fact that even thus early the progress of mathematics was determined by that of astronomy. And here, indeed, we see exemplified the truth, which the subsequent history of science frequently illustrates, that before any more abstract division makes a further advance, some more concrete division suggests the necessity for that advance—presents the new order of questions to be solved. Before astronomy put before Hipparchus the problem of solar tables, there was nothing to raise the question of the relations between lines and angles: the subject-matter of trigonometry had not been conceived.

Just incidentally noticing the circumstance that the epoch we are describing witnessed the evolution of algebra, a comparatively abstract division of mathematics, by the union of its less abstract divisions, geometry and arithmetic (a fact proved by the earliest extant samples of algebra, which are half algebraic, half geometric) we go on to observe that during the era in which mathematics and astronomy were thus advancing, rational mechanics made its second step; and something was done towards giving a quantitative form to hydrostatics, optics, and acoustics. In each case we shall see how the idea of equality underlies all quantitative prevision; and in what simple forms this idea is first applied.

As already shown, the first theorem established in mechanics was, that equal weights suspended from a lever with equal arms would remain in equilibrium. Archimedes discovered that a lever with unequal arms was in equilib-

rium when one weight was to its arm as the other arm to its weight; that is—when the numerical relation between one weight and its arm was *equal* to the numerical relation between the other arm and its weight.

The first advance made in hydrostatics, which we also owe to Archimedes, was the discovery that fluids press *equally* in all directions; and from this followed the solution of the problem of floating bodies; namely, that they are in equilibrium when the upward and downward pressures are *equal*.

In optics, again, the Greeks found that the angle of incidence is *equal* to the angle of reflection; and their knowledge reached no further than to such simple deductions from this as their geometry sufficed for. In acoustics they ascertained the fact that three strings of *equal* lengths would yield the octave, fifth and fourth, when strained by weights having certain definite ratios; and they did not progress much beyond this. In the one of which cases we see geometry used in elucidation of the laws of light; and in the other, geometry and arithmetic made to measure certain phenomena of sound.

While sundry sciences had thus reached the first stages of quantitative prevision, others were progressing in qualitative prevision. It must suffice just to note that some small generalizations were made respecting evaporation, and heat, and electricity, and magnetism, which, empirical as they were, did not in that respect differ from the first generalizations of every science; that the Greek physicians had made advances in physiology and pathology, which, considering the great imperfection of our present knowledge, are by no means to be despised; that zoology had been so far systematized by Aristotle, as, to some extent, enabled him from the presence of certain organs to predict the presence of others; that in Aristotle's *Politics*, is shown progress towards a scientific conception of social phenomena, and sundry previsions respecting

them; and that in the state of the Greek societies, as well as in the writings of Greek philosophers, we may recognize both an increasing clearness in the conception of equity and some appreciation of the fact that social stability depends on the maintenance of equitable relations. Space permitting, we might dwell on the causes which retarded the development of some of the sciences, as for example, chemistry; showing that relative complexity had nothing to do with it—that the oxidation of a piece of iron is a simpler phenomenon than the recurrence of eclipses, and the discovery of carbonic acid less difficult than that of the precession of the equinoxes. The relatively slow advance of chemical knowledge might be shown to be due, partly to the fact that its phenomena were not daily thrust on men's notice as those of astronomy were; partly to the fact that Nature does not habitually supply the means, and suggest the modes of investigation, as in the sciences dealing with time, extension, and force; partly to the fact that the great majority of the materials with which chemistry deals, instead of being ready to hand, are made known only by the arts in their slow growth; and partly to the fact that even when known, their chemical properties are not self-exhibited, but have to be sought out by experiment.

Merely indicating these considerations, however, let us go on to contemplate the progress and mutual influence of the sciences in modern days; only parenthetically noticing how, on the revival of the scientific spirit, the successive stages achieved exhibit the dominance of the law hitherto traced—how the primary idea in dynamics, a uniform force, was defined by Galileo to be a force which generates *equal* velocities in *equal* successive times—how the uniform action of gravity was first experimentally determined by showing that the time elapsing before a body thrown up, stopped, was *equal* to the time it took to fall—how the first fact in compound motion which Galileo

ascertained was, that a body projected horizontally, will describe *equal* horizontal spaces in *equal* times, compounded vertical spaces described which increase by equal increments in *equal* times—how his discovery respecting the pendulum was, that its oscillations occupy *equal* intervals of time whatever their lengths—how the law which he established that in any machine the weights that balance each other, are reciprocally as their virtual velocities implies that the relation of one set of weights to their velocities *equals* the relation of the other set of velocities to their weights;—and how thus his achievements consisted in showing the equalities of certain magnitudes and relations, whose equalities had not been previously recognized.

And now, but only now, physical astronomy became possible. The simple laws of force had been disentangled from those of friction and atmospheric resistance by which all their earthly manifestations are disguised. Progressing knowledge of *terrestrial physics* had given a due insight into these disturbing causes; and, by an effort of abstraction, it was perceived that all motion would be uniform and rectilinear unless interfered with by external forces. Geometry and mechanics having diverged from a common root in men's sensible experiences, and having, with occasional inosculations, been separately developed, the one partly in connexion with astronomy, the other solely by analyzing terrestrial movements, now join in the investigations of Newton to create a true theory of the celestial motions. And here, also, we have to notice the important fact that, in the very process of being brought jointly to bear upon astronomical problems, they are themselves raised to a higher phase of development. For it was in dealing with the questions raised by celestial dynamics that the then incipient infinitesimal calculus was unfolded by Newton and his continental successors; and it was from inquiries into the mechanics of the solar system that the general theorems of mechanics contained in the

Principia—many of them of purely terrestrial application —took their rise. Thus, as in the case of Hipparchus, the presentation of a new order of concrete facts to be analyzed, led to the discovery of new abstract facts; and these abstract facts then became instruments of access to endless groups of concrete facts previously beyond quantitative treatment.

Meanwhile, physics had been carrying further that progress without which, as just shown, rational mechanics could not be disentangled. In hydrostatics, Stevinus had extended and applied the discovery of Archimedes. Torricelli had proved atmospheric pressure, "by showing that this pressure sustained different liquids at heights inversely proportional to their densities;" and Pascal "established the necessary diminution of this pressure at increasing heights in the atmosphere": discoveries which in part reduced this branch of science to a quantitative form. Something had been done by Daniel Bernouilli towards the dynamics of fluids. The thermometer had been invented; and sundry small generalizations reached by it. Huyghens and Newton had made considerable progress in optics; Newton had approximately calculated the rate of transmission of sound; and the continental mathematicians had ascertained some of the laws of sonorous vibrations. Magnetism and electricity had been considerably advanced by Gilbert. Chemistry had got as far as the mutual neutralization of acids and alkalies. And Leonardo da Vinci had advanced in geology to the conclusion that the deposition of animal remains in marine strata is the origin of fossils. Our present purpose does not require that we should give particulars. Here it only concerns us to illustrate the *consensus* subsisting in this stage of growth, and afterwards. Let us look at a few cases.

The theoretic law of the velocity of sound deduced by Newton from purely mechanical data, was found wrong by one-sixth. The error remained unaccounted for until the

time of Laplace, who, suspecting that the heat disengaged by the compression of the undulating strata of the air, gave additional elasticity, and so produced the difference, made the needful calculations and found he was right. Thus acoustics was arrested until thermology overtook and aided it. When Boyle and Marriot had discovered the relation between the densities of gases and the pressures they are subject to; and when it thus became possible to calculate the rate of decreasing density in the upper parts of the atmosphere; it also became possible to make approximate tables of the atmospheric refraction of light. Thus optics, and with it astronomy, advanced with barology. After the discovery of atmospheric pressure had led to the invention of the air-pump by Otto Guericke; and after it had become known that evaporation increases in rapidity as atmospheric pressure decreases; it became possible for Leslie, by evaporation in a vacuum, to produce the greatest cold known; and so to extend our knowledge of thermology by showing that there is no zero within reach of our researches. When Fourier had determined the laws of conduction of heat, and when the Earth's temperature had been found to increase below the surface one degree in every forty yards, there were data for inferring the past condition of our globe; the vast period it has taken to cool down to its present state; and the immense age of the solar system—a purely astronomical consideration. Chemistry having advanced sufficiently to supply the needful materials, and a physiological experiment having furnished the requisite hint, there came the discovery of galvanic electricity. Galvanism reacting on chemistry disclosed the metallic bases of the alkalies and earths, and inaugurated the electro-chemical theory; in the hands of Oersted and Ampère it led to the laws of magnetic action; and by its aid Faraday has detected significant facts relative to the constitution of light. Brewster's discoveries respecting double refraction and

dipolarization proved the essential truth of the classification of crystalline forms according to the number of axes, by showing that the molecular constitution depends on the axes. Now in these and in numerous other cases, the mutual influence of the sciences has been quite independent of any supposed hierarchical order. Often, too, their inter-actions are more complex than as thus instanced—involve more sciences than two. One illustration of this must suffice. We quote it in full from the *History of the Inductive Sciences*. In Book XI., chap. II., on "The Progress of the Electrical Theory," Dr. Whewell writes:—

"Thus at that period, mathematics was behind experiment, and a problem was proposed, in which theoretical numerical results were wanted for comparison with observation, but could not be accurately obtained; as was the case in astronomy also, till the time of the approximate solution of the problem of three bodies, and the consequent formation of the tables of the moon and planets, on the theory of universal gravitation. After some time, electrical theory was relieved from this reproach, mainly in consequence of the progress which astronomy had occasioned in pure mathematics. About 1801 there appeared in the *Bulletin des Sciences*, an exact solution of the problem of the distribution of electric fluid on a spheroid, obtained by Biot, by the application of the peculiar methods which Laplace had invented for the problem of the figure of the planets. And, in 1811, M. Poisson applied Laplace's artifices to the case of two spheres acting upon one another in contact, a case to which many of Coulomb's experiments were referrible; and the agreement of the results of theory and observation, thus extricated from Coulomb's numbers obtained above forty years previously, was very striking and convincing."

Not only do the sciences affect each other after this direct manner, but they affect each other indirectly. Where there is no dependence, there is yet analogy—*likeness of relations;* and the discovery of the relations subsisting among one set of phenomena, constantly suggests a search for similar relations among another set. Thus the established fact that the force of gravitation varies inversely as the square of the distance, being recognized as a necessary characteristic of all influences proceeding from a centre, raised the suspicion that heat and light follow the same law; which proved to be the case—a suspicion and a

confirmation which were repeated in respect to the electric and magnetic forces. Thus, again, the discovery of the polarization of light led to experiments which ended in the discovery of the polarization of heat—a discovery that could never have been made without the antecedent one. Thus, too, the known refrangibility of light and heat lately produced the inquiry whether sound also is not refrangible; which on trial it turns out to be. In some cases, indeed, it is only by the aid of conceptions derived from one class of phenomena that hypotheses respecting other classes can be formed. The theory, at one time favoured, that evaporation is a solution of water in air, assumed that the relation between water and air is *like* the relation between water and a dissolved solid; and could never have been conceived if relations like that between salt and water had not been previously known. Similarly the received theory of evaporation—that it is a diffusion of the particles of the evaporating fluid in virtue of their atomic repulsion—could not have been entertained without a foregoing experience of magnetic and electric repulsions. So complete in recent days has become this *consensus* among the sciences, caused either by the natural entanglement of their phenomena, or by analogies between the relations of their phenomena, that scarcely any considerable discovery concerning one order of facts now takes place, without shortly leading to discoveries concerning other orders.

To produce a complete conception of this process of scientific evolution it would be needful to go back to the beginning, and trace in detail the growth of classifications and nomenclatures; and to show how, as subsidiary to science, they have acted upon it while it has reacted upon them. We can only now remark that, on the one hand, classifications and nomenclatures have aided science by subdividing the subject-matter of research, and giving fixity and diffusion to the truths disclosed; and that on the other hand, they have caught from it that increasing

quantitativeness, and that progress from considerations touching single phenomena to considerations touching the relations among many phenomena, which we have been describing. Of this last influence a few illustrations must be given. In chemistry it is seen in the facts that the dividing of matter into the four elements was ostensibly based on the single property of weight, that the first truly chemical division into acid and alkaline bodies, grouped together bodies which had not simply one property in common but in which one property was constantly related to many others, and that the classification now current, places together in the groups *supporters of combustion, metallic and non-metallic bases, acids, salts*, &c., bodies which are often quite unlike in sensible qualities, but which are like in the majority of their *relations* to other bodies. In mineralogy again, the first classifications were based on differences in aspect, texture, and other physical attributes. Berzelius made two attempts at a classification based solely on chemical constitution. That now current recognizes, as far as possible, the *relations* between physical and chemical characters. In botany the earliest classes formed were *trees*, *shrubs*, and *herbs*: magnitude being the basis of distinction. Dioscorides divided vegetables into *aromatic*, *alimentary*, *medicinal*, and *vinous*: a division of chemical character. Cæsalpinus classified them by the seeds and seed-vessels, which he preferred because of the *relations* found to subsist between the character of the fructification and the general character of the other parts. While the "natural system" since developed, carrying out the doctrine of Linnæus, that "the natural orders must be formed by attention not to one or two, but to *all* the parts of plants," bases its divisions on like peculiarities which are found to be *constantly related* to the greatest number of other like peculiarities. And similarly in zoology, the successive classifications, from having been originally determined by external and often

subordinate characters not indicative of the essential nature, have been more and more determined by those internal and fundamental differences, which have uniform *relations* to the greatest number of other differences. Nor shall we be surprised at this analogy between the modes of progress of positive science and classification, when we bear in mind that both proceed by making generalizations; that both enable us to make previsions, differing only in their precision; and that while the one deals with equal properties, magnitudes, and relations, the other deals with properties and relations which approximate towards equality in various degrees.

Without further argument it will, we think, be admitted that the sciences are none of them separately evolved—are none of them independent either logically or historically; but that all of them have, in a greater or less degree, required aid and reciprocated it. Indeed, it needs but to throw aside hypotheses, and contemplate the mixed character of surrounding phenomena, to see at once that these notions of division and succession in the kinds of knowledge are simply scientific fictions: good, if regarded merely as aids to study; bad, if regarded as representing realities in Nature. No facts whatever are presented to our senses uncombined with other facts—no facts whatever but are in some degree disguised by accompanying facts: disguised in such a manner that all must be partially understood before any one can be understood. If it be said, as by M. Comte, that gravitating force should be treated of before other forces, seeing that all things are subject to it, it may on like grounds be said that heat should be first dealt with; seeing that thermal forces are everywhere in action. Nay more, it may be urged that the ability of any portion of matter to manifest visible gravitative phenomena depends on its state of aggregation, which is determined by heat; that only by the aid of thermology can we explain those apparent exceptions to

the gravitating tendency which are presented by steam and smoke, and so establish its universality; and that, indeed, the very existence of the Solar System in a solid form is just as much a question of heat as it is one of gravitation. Take other cases:—All phenomena recognized by the eyes, through which only are the data of exact science ascertainable, are complicated with optical phenomena, and cannot be exhaustively known until optical principles are known. The burning of a candle cannot be explained without involving chemistry, mechanics, thermology. Every wind that blows is determined by influences partly solar, partly lunar, partly hygrometric; and implies considerations of fluid equilibrium and physical geography. The direction, dip, and variations of the magnetic needle, are facts half terrestrial, half celestial—are caused by earthly forces which have cycles of change corresponding with astronomical periods. The flowing of the gulf-stream and the annual migration of icebergs towards the equator, involve in their explanation the Earth's rotation and spheroidal form, the laws of hydrostatics, the relative densities of cold and warm water, and the doctrines of evaporation. It is no doubt true, as M. Comte says, that "our position in the Solar System, and the motions, form, size, and equilibrium of the mass of our world among the planets, must be known before we can understand the phenomena going on at its surface." But, fatally for his hypothesis, it is also true that we must understand a great part of the phenomena going on at its surface before we can know its position, &c., in the Solar System. It is not simply that, as already shown, those geometrical and mechanical principles by which celestial appearances are explained, were first generalized from terrestrial experiences; but it is that even the obtainment of correct data on which to base astronomical generalizations, implies advanced terrestrial physics. Until after optics had made considerable advance, the Copernican

system remained but a speculation. A single modern observation on a star has to undergo a careful analysis by the combined aid of various sciences—has to *be digested by the organism of the sciences;* which have severally to assimilate their respective parts of the observation, before the essential fact it contains is available for the further development of astronomy. It has to be corrected not only for nutation of the Earth's axis and for precession of the equinoxes, but for aberration and for refraction; and the formation of the tables by which refraction is calculated, presupposes knowledge of the law of decreasing density in the upper atmospheric strata, of the law of decreasing temperature and the influence of this on the density, and of hygrometric laws as also affecting density. So that, to get materials for further advance, astronomy requires not only the indirect aid of the sciences which have presided over the making of its improved instruments, but the direct aid of an advanced optics, of barology, of thermology, of hygrometry; and if we remember that these delicate observations are in some cases registered electrically, and that they are further corrected for the "personal equation" —the time elapsing between seeing and registering, which differs with different observers—we may even add electricity and psychology. And here, before leaving these illustrations, and especially this last one, let us not omit to notice how well they exhibit that increasingly active *consensus* of the sciences which characterizes their advancing development. Besides finding that in these later times a discovery in one science commonly causes progress in others; besides finding that a great part of the questions with which modern science deals are so mixed as to require the co-operation of many sciences for their solution; we find that, to make a single good observation in the purest of the natural sciences, requires the combined aid of half a dozen other sciences.

Perhaps the clearest comprehension of the interconnected

growth of the sciences may be obtained by contemplating that of the arts, to which it is strictly analogous, and with which it is bound up. Most intelligent persons must have been occasionally struck with the numerous antecedents pre-supposed by one of our processes of manufacture. Let him trace the production of a printed cotton, and consider all that is implied by it. There are the many successive improvements through which the power-looms reached their present perfection; there is the steam-engine that drives them, having its long history from Papin downwards; there are the lathes in which its cylinder was bored, and the string of ancestral lathes from which those lathes proceeded; there is the steam-hammer under which its crank shaft was welded; there are the puddling furnaces, the blast-furnaces, the coal-mines and the iron-mines needful for producing the raw material; there are the slowly improved appliances by which the factory was built, and lighted, and ventilated; there are the printing engine, and the dye-house, and the colour-laboratory with its stock of materials from all parts of the world, implying cochineal-culture, logwood-cutting, indigo-growing; there are the implements used by the producers of cotton, the gins by which it is cleaned, the elaborate machines by which it is spun; there are the vessels in which cotton is imported, with the building-slips, the rope-yards, the sail-cloth factories, the anchor-forges, needful for making them; and besides all these directly necessary antecedents, each of them involving many others, there are the institutions which have developed the requisite intelligence, the printing and publishing arrangements which have spread the necessary information, the social organization which has rendered possible such a complex co-operation of agencies. Further analysis would show that the many arts thus concerned in the economical production of a child's frock, have each been brought to its present efficiency by slow steps which the other arts have aided; and that from the beginning this reciprocity has been on

the increase. It needs but on the one hand to consider how impossible it is for the savage, even with ore and coal ready, to produce so simple a thing as an iron hatchet; and then to consider, on the other hand, that it would have been impracticable among ourselves, even a century ago, to raise the tubes of the Britannia bridge from lack of the hydraulic press; to see how mutually dependent are the arts, and how all must advance that each may advance. Well, the sciences are involved with each other in just the same manner. They are, in fact, inextricably woven into this same complex web of the arts; and are only conventionally independent of it. Originally the two were one. How to fix the religious festivals; when to sow; how to weigh commodities; and in what manner to measure ground; were the purely practical questions out of which arose astronomy, mechanics, geometry. Since then there has been a perpetual inosculation of the sciences and the arts. Science has been supplying art with truer generalizations and more completely quantitative previsions. Art has been supplying science with better materials, and more perfect instruments. And all along the interdependence has been growing closer, not only between art and science, but among the arts themselves, and among the sciences themselves. How completely the analogy holds throughout, becomes yet clearer when we recognize the fact that *the sciences are arts to one another*. If, as occurs in almost every case, the fact to be analyzed by any science, has first to be prepared—to be disentangled from disturbing facts by the afore discovered methods of other sciences; the other sciences so used, stand in the position of arts. If, in solving a dynamical problem, a parallelogram is drawn, of which the sides and diagonal represent forces, and by putting magnitudes of extension for magnitudes of force a measurable relation is established between quantities not else to be dealt with; it may be fairly said that geometry plays towards mechanics much the same part that the fire of the founder plays towards the metal he is going to cast.

If, in analyzing the phenomena of the coloured rings surrounding the point of contact between two lenses, a Newton ascertains by calculation the amount of certain interposed spaces, far too minute for actual measurement; he employs the science of number for essentially the same purpose as that for which the watchmaker employs tools. If, before calculating the orbit of a comet from its observed position, the astronomer has to separate all the errors of observation, it is manifest that the refraction-tables, and logarithm-books, and formulæ, which he successively uses, serve him much as retorts, and filters, and cupels serve the assayer who wishes to separate the pure gold from all accompanying ingredients. So close, indeed, is the relationship, that it is impossible to say where science begins and art ends. All the instruments of the natural philosopher are the products of art; the adjusting one of them for use is an art; there is art in making an observation with one of them; it requires art properly to treat the facts ascertained; nay, even the employing established generalizations to open the way to new generalizations, may be considered as art. In each of these cases previously organized knowledge becomes the implement by which new knowledge is got at: and whether that previously organized knowledge is embodied in a tangible apparatus or in a formula, matters not in so far as its essential relation to the new knowledge is concerned. If art is applied knowledge, then such portion of a scientific investigation as consists of applied knowledge is art. Hence we may even say that as soon as any prevision in science passes out of its originally passive state, and is employed for reaching other previsions, it passes from theory into practice—becomes science in action—becomes art. And after contemplating these facts, we shall the more clearly perceive that as the connexion of the arts with each other has been becoming more intimate; as the help given by sciences to arts and by arts to sciences, has been age by age increasing; so the interdependence of the sciences

themselves has been ever growing greater, their relations more involved, their *consensus* more active.

In here ending our sketch of the Genesis of Science, we are conscious of having done the subject but scant justice. Two difficulties have stood in our way: one, the having to touch on so many points in such small space; the other, the necessity of treating in serial arrangement a process which is not serial. Nevertheless, we believe the evidence assigned suffices to substantiate the leading propositions with which we set out. Inquiry into the first stages of science confirms the conclusion drawn from analysis of science as now existing, that it is not distinct from common knowledge, but an outgrowth from it—an extension of perception by means of reason. That more specific characteristic of scientific previsions, which was analytically shown to distinguish them from the previsions of uncultured intelligence—their quantitativeness—we also see to have been the characteristic alike of the initial steps in science, and of all the steps succeeding them. The facts and admissions cited in disproof of the assertion that the sciences follow one another, both logically and historically, in the order of their decreasing generality, have been enforced by the instances we have met with, showing that a more general science as much owes its progress to the presentation of new problems by a more special science, as the more special science owes its progress to the solutions which the more general science is thus led to attempt—instances, therefore, illustrating the position that scientific advance is as much from the special to the general as from the general to the special. Quite in harmony with this position we find to be the admissions that the sciences are as branches of one trunk, and that they were at first cultivated simultaneously. This harmony becomes the more marked on finding, as we have done, not only that the sciences have a common root, but that science in

general has a common root with language, classification, reasoning, art; that throughout civilization these have advanced together, acting and reacting upon each other just as the separate sciences have done; and that thus the development of intelligence in all its divisions and subdivisions has conformed to this same law which we have shown that the sciences conform to. From all which we may perceive that the sciences can with no greater propriety be arranged in a succession, than language, classification, reasoning, art, and science, can be arranged in a succession; that, however needful a succession may be for the convenience of books and catalogues, it must be recognized as merely a convention; and that so far from its being the function of a philosophy of the sciences to establish a hierarchy, it is its function to show that the linear arrangements required for literary purposes, have none of them any basis either in Nature or History.

There is one further remark we must not omit—a remark touching the importance of the question that has been discussed. Topics of this abstract nature are commonly slighted as of no practical moment; and, doubtless, many will think it of little consequence what theory respecting the genesis of science may be entertained. But the value of truths is often great, in proportion as their generality is wide. And it must be so here. A correct theory of the development of the sciences must have an important effect on education; and, through education, on civilization. Much as we differ from him in other respects, we agree with M. Comte in the belief that, rightly conducted, the education of the individual must have a certain correspondence with the evolution of the race. No one can contemplate the facts we have cited in illustration of the early stages of science, without recognizing the *necessity* of the processes through which those stages were reached—a necessity which, in respect to the leading truths, may likewise be traced in all after stages. This necessity,

originating in the very nature of the phenomena to be analyzed and the faculties to be employed, partially applies to the mind of the child as to that of the savage. We say partially, because the correspondence is not special but general only. Were the *environment* the same in both cases, the correspondence would be complete. But though the surrounding material out of which science is to be organized, is, in many cases, the same to the juvenile mind and the aboriginal mind, it is not so throughout; as, for instance, in the case of chemistry, the phenomena of which are accessible to the one but were inaccessible to the other. Hence, in proportion as the environment differs, the course of evolution must differ. After admitting exceptions, however, there remains a substantial parallelism; and, if so, it is of moment to ascertain what really has been the process of scientific evolution. The establishment of an erroneous theory must be disastrous in its educational results; while the establishment of a true one must be fertile in school-reforms and consequent social benefits.

THE CLASSIFICATION OF THE SCIENCES.

[*First published as a brochure in April* 1864. *The preface to the second edition, published in April* 1869, *I reproduce because of certain facts contained in it which are not without interest.*]

THE first edition of this Essay is not yet out of print. But a proposal to translate it into French having been made by Professor Réthoré, I have decided to prepare a new edition free from the imperfections which criticism and further thought have disclosed, rather than allow these imperfections to be reproduced.

The occasion has almost tempted me into some amplification. Further arguments against the classification of M. Comte, and further arguments in support of the classification here set forth, have pleaded for utterance. But reconsideration has convinced me that it is both needless and useless to say more—needless because those who are not committed will think the case sufficiently strong as it stands; and useless because to those who are committed, additional reasons will seem as inadequate as the original ones. [In the preface to the third edition, however, a reason is given for a change of decision on this point at that time made (February 1871): the reason being "the publication of several objections by Prof. Bain in his Logic."]

This last conclusion is thrust on me by seeing how little M. Littré, the leading expositor of M. Comte, is influenced by fundamental objections the force of which he admits. After quoting one of these, he says, with a candour equally

rare and admirable, that he has vainly searched M. Comte's works and his own mind for an answer. Nevertheless, he adds—"j'ai réussi, je crois, à écarter l'attaque de M. Herbert Spencer, et à sauver le fond par des sacrifices indispensables mais accessoires." The sacrifices are these. He abandons M. Comte's division of Inorganic Science into Celestial Physics and Terrestrial Physics—a division which, in M. Comte's scheme, takes precedence of all the rest; and he admits that neither logically nor historically does Astronomy come before Physics, as M. Comte alleges. After making these sacrifices, which most will think too lightly described as "sacrifices indispensables mais accessoires," M. Littré proceeds to rehabilitate the Comtean classification in a way which he considers satisfactory, but which I do not understand. In short, the proof of these incongruities affects his faith in the Positivist theory of the sciences, no more than the faith of a Christian is affected by proof that the Gospels contradict one another.

Here in England I have seen no attempt to meet the criticisms with which M. Littré thus deals. There has been no reply to the allegation, based on examples, that the several sciences do not develop in the order of their decreasing generality; nor to the allegation, based on M. Comte's own admissions, that within each science the progress is not, as he says it is, from the general to the special; nor to the allegation that the seeming historical precedence of Astronomy over Physics in M. Comte's pages, is based on a verbal ambiguity—a mere sleight of words; nor to the allegation, abundantly illustrated, that a progression in an order the reverse of that asserted by M. Comte may be as well substantiated; nor to various minor allegations equally irreconcileable with his scheme. I have met with nothing more than iteration of the statement that the sciences *do* conform, logically and historically, to the order in which M. Comte places them; regardless of the assigned evidence that they *do not*.

Under these circumstances it is unnecessary for me to

say more; and I think I am warranted in continuing to hold that the Comtean classification of the sciences is demonstrably untenable.

In an essay on "The Genesis of Science," originally published in 1854, I endeavoured to show that the Sciences cannot be rationally arranged in serial order. Proof was given that neither the succession in which the Sciences are placed by M. Comte (to a criticism of whose scheme the essay was in part devoted), nor any other succession in which the Sciences can be placed, represents either their logical dependence or their historical dependence. To the question—How may their relations be rightly expressed? I did not then attempt any answer. This question I propose now to consider.

A true classification includes in each class, those objects which have more characteristics in common with one another, than any of them have in common with any objects excluded from the class. Further, the characteristics possessed in common by the colligated objects, and not possessed by other objects, involve more numerous dependent characteristics. These are two sides of the same definition. For things possessing the greatest number of attributes in common, are things that possess in common those essential attributes on which the rest depend; and, conversely, the possession in common of the essential attributes, implies the possession in common of the greatest number of attributes. Hence, either test may be used as convenience dictates.

If, then, the Sciences admit of classification at all, it must be by grouping together the like and separating the unlike, as thus defined. Let us proceed to do this.

The broadest natural division among the Sciences, is the division between those which deal with the abstract relations

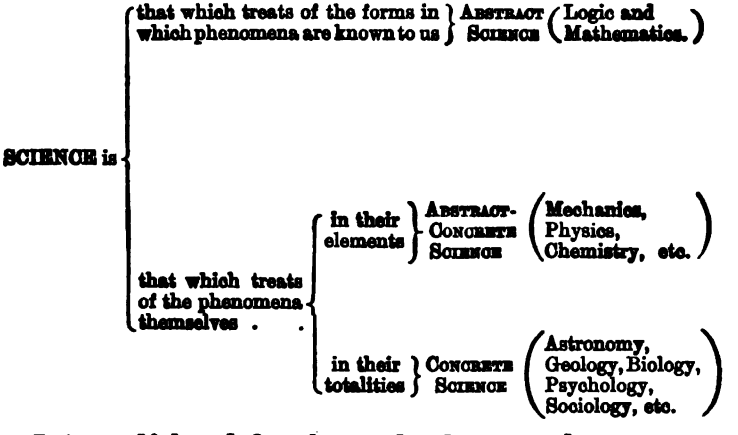
under which phenomena are presented to us, and those which deal with the phenomena themselves. Relations of whatever orders, are nearer akin to one another than they are to any objects. Objects of whatever orders, are nearer akin to one another than they are to any relations. Whether, as some hold, Space and Time are nothing but forms of Thought*; or whether, as I hold myself, they are forms of Things, that have generated forms of Thought through organized and inherited experience of Things; it is equally true that Space and Time are contrasted absolutely with the existences disclosed to us in Space and Time; and hence the Sciences which deal exclusively with Space and Time, are separated by the profoundest of all distinctions from the Sciences which deal with the existences contained in Space and Time. Space is the abstract of all relations of co-existence. Time is the abstract of all relations of sequence. And dealing as they do entirely with relations of co-existence and sequence, in their general or special forms, Logic and Mathematics form a class of the Sciences more widely unlike the rest, than any of the rest are from one another.

The Sciences which deal with existences themselves, instead of the blank forms in which existences are presented to us, admit of a sub-division less profound than the division above made, but more profound than any of the divisions among the Sciences individually considered. They

* I have been charged with misrepresenting Kant and misunderstanding him, because I have used the expression "forms of Thought" instead of "forms of Intuition." Elsewhere I have shown that my argument against him remains equally valid when the phrase "forms of Intuition" is used. Here I may in the first place add that I did but follow some Kantists in saying "forms of Thought," and I may add in the second place that the objection is superficial and quite irrelevant to the issue. Thought when broadly used as antithetical to Things includes Intuition: it comprehends in this sense all that is subjective as distinguished from all that is objective, and in so doing comprehends Intuition. Nor is this all. There cannot be Intuition without Thought: every act of intuition implies an act of classing without which the thing intuited is not known as such or such; and every act of classing is an act of thought.

fall into two classes, having quite different aspects, aims, and methods. Every phenomenon is more or less composite—is a manifestation of force under several distinct modes. Hence result two objects of inquiry. We may study the component modes of force separately; or we may study them as co-operating to generate in this composite phenomenon. On the one hand, neglecting all the incidents of particular cases, we may aim to educe the laws of each mode of force, when it is uninterfered with. On the other hand, the incidents of the particular case being given, we may seek to interpret the entire phenomenon, as a product of the several forces simultaneously in action. The truths reached through the first kind of inquiry, though concrete inasmuch as they have actual existences for their subject-matters, are abstract inasmuch as they refer to the modes of existence apart from one another; while the truths reached by the second kind of inquiry are properly concrete, inasmuch as they formulate the facts in their combined order, as they occur in Nature.

The Sciences, then, in their main divisions, stand thus:—



It is needful to define the words *abstract* and *concrete* as thus used; since they are sometimes used with other

meanings. M. Comte divides Science into abstract and concrete; but the divisions which he distinguishes by these names are quite unlike those above made. Instead of regarding some Sciences as wholly abstract, and others as wholly concrete, he regards each Science as having an abstract part, and a concrete part. There is, according to him, an abstract mathematics and a concrete mathematics —an abstract biology and concrete biology. He says:— "Il faut distinguer, par rapport à tous les ordres de phénomènes, deux genres de sciences naturelles: les unes abstraites, générales, ont pour objet la découverte des lois qui régissent les diverses classes de phénomènes, en considérant tous les cas qu'on peut concevoir; les autres concrètes, particulières, descriptives, et qu'on désigne quelquefois sous le nom de sciences naturelles proprement dites, consistent dans l'application de ces lois a l'histoire effective des différens êtres existans." And to illustrate the distinction, he names general physiology as abstract, and zoology and botany as concrete. Here it is manifest that the words *abstract* and *general* are used as synonymous. They have, however, different meanings; and confusion results from not distinguishing their meanings. Abstractness means *detachment from* the incidents of particular cases. Generality means *manifestation in* numerous cases. On the one hand, the essential nature of some phenomenon is considered, apart from disguising phenomena. On the other hand, the frequency of the phenomenon, with or without disguising phenomena, is the thing considered. Among the phenomena presented by numbers, which are purely ideal, the two coincide; but excluding these, an abstract truth is not realizable to perception in any case of which it is asserted, whereas a general truth is realizable to perception in every case of which it is asserted. Some illustrations will make the distinction clear. Thus it is an abstract truth that the angle contained in a semi-circle is a right angle— abstract in the sense that though it does not hold of actually-

constructed semi-circles and angles, which are always inexact, it holds of the ideal semi-circles and angles abstracted from real ones; but this is not a general truth, either in the sense that it is commonly manifested in Nature, or in the sense that it is a space-relation that comprehends many minor space-relations: it is a quite special space-relation. Again, that the momentum of a body causes it to move in a straight line at a uniform velocity, is an abstract-concrete truth—a truth abstracted from certain experiences of concrete phenomena; but it is by no means a general truth: so little generality has it, that no one fact in Nature displays it. Conversely, surrounding things supply us with hosts of general truths that are not in the least abstract. It is a general truth that the planets go round the Sun from West to East—a truth which holds good in several hundred cases (including the cases of the planetoids); but this truth is not at all abstract, since it is perfectly realized as a concrete fact in every one of these cases. Every vertebrate animal whatever, has a double nervous system; all birds and all mammals are warm-blooded—these are general truths, but they are concrete truths: that is to say, every vertebrate animal individually presents an entire and unqualified manifestation of this duality of the nervous system; every living bird exemplifies absolutely or completely the warm-bloodedness of birds. What we here call, and rightly call, a general truth, is simply a proposition which *sums up* a number of our actual experiences; and not the expression of a truth *drawn from* our actual experiences, but never presented to us in any of them. In other words, a general truth colligates a number of particular truths; while an abstract truth colligates no particular truths, but formulates a truth which certain phenomena all involve, though it is actually seen in none of them.

Limiting the words to their proper meanings as thus defined, it becomes manifest that the three classes of

Sciences above separated, are not distinguishable at all by differences in their degrees of generality. They are all equally general; or rather they are all, considered as groups, universal. Every object whatever presents at once the subject-matter for each of them. In every fragment of substance we have simultaneously illustrated the abstract truths of relation in Time and Space; the abstract-concrete truths in conformity with which the fragment manifests its several modes of force; and the concrete truths resulting from the joint manifestation of these modes of force, and which give to the fragment the characters by which it is known as such or such. Thus these three classes of Sciences severally formulate different, but co-extensive, classes of facts. Within each group there are truths of greater and less generality: there are general abstract truths, and special abstract truths; general abstract-concrete truths, and special abstract-concrete truths; general concrete truths, and special concrete truths. But while within each class there are groups and sub-groups and sub-sub-groups which differ in their degrees of generality, the classes themselves differ only in their degrees of abstractness.*

Let us pass to the sub-divisions of these classes. The first class is separable into two parts—the one containing universal truths, the other non-universal truths. Dealing

* Some propositions laid down by M. Littré, in his book—*Auguste Comte et la Philosophie Positive* (published in 1863), may fitly be dealt with here. In the candid and courteous reply he makes to my strictures on the Comtean classification in "The Genesis of Science," he endeavours to clear up some of the inconsistencies I pointed out; and he does this by drawing a distinction between objective generality and subjective generality. He says—"qu'il existe deux ordres de généralité, l'une objective et dans les choses, l'autre subjective, abstraite et dans l'esprit." This sentence, in which M. Littré makes subjective generality synonymous with abstractness, led me at first to conclude that he had in view the same distinction as that which I have above explained between generality and abstractness. On re-reading the paragraph, however, I found this was not the case. In a previous sentence he says—"La biologie a passé de la considération des organes à celles des tissus,

wholly with relations apart from related things, Abstract Science considers first, that which is common to all relations whatever; and, second, that which is common to each order of relations. Besides the indefinite and variable connexions which exist among phenomena, as occurring together in Space and Time, we find that there are also definite and invariable connexions—that between each kind of phenomenon and certain other kinds of phenomena, there exist uniform relations. This is a universal abstract truth—that there is an unchanging order, or fixity of law, in Space and Time. We come next to the several kinds of unchanging order, which, taken together, form the subjects of the

plus généraux que les organes, et de la considération des tissus à celle des éléments anatomiques, plus généraux que les tissus. Mais cette généralité croissante est subjective non objective, abstraite non concrète." Here it is manifest that abstract and concrete, are used in senses analogous to those in which they are used by M. Comte; who, as we have seen, regards general physiology as abstract and zoology and botany as concrete. And it is further manifest that the word abstract, as thus used, is not used in its proper sense. For, as above shown, no such facts as those of anatomical structure can be abstract facts; but can only be more or less general facts. Nor do I understand M. Littré's point of view when he regards these more general facts of anatomical structure, as *subjectively* general and not *objectively* general. The structural phenomena presented by any tissue, such as mucous membrane, are more general than the phenomena presented by any of the organs which mucous membrane goes to form, simply in the sense that the phenomena peculiar to the membrane are repeated in a greater number of instances than the phenomena peculiar to any organ into the composition of which the membrane enters. And, similarly, such facts as have been established respecting the anatomical elements of tissues, are more general than the facts established respecting any particular tissue, in the sense that they are facts which the various parts of organized bodies exhibit in a greater number of cases—they are *objectively* more general; and they can be called *subjectively* more general only in the sense that the conception corresponds with the phenomena.

Let me endeavour to clear up this point:—There is, as M. Littré truly says, a decreasing generality that is objective. If we omit the phenomena of Dissolution, which are changes from the special to the general, all changes which matter undergoes are from the general to the special—are changes involving a decreasing generality in the united groups of attributes. This is the progress of *things*. The progress of *thought*, is not only in the same direction, but also in the opposite direction. The investigation of Nature discloses

second division of Abstract Science. Of this second division, the most general sub-division is that which deals with the natures of the connexions in Space and Time, irrespective of the terms connected. The conditions under which we may predicate a relation of coincidence or proximity in Space and Time (or of non-coincidence or non-proximity) from the subject-matter of Logic. Here the natures and amounts of the terms between which the relations are

an increasing number of specialities; but it simultaneously discloses more and more the generalities within which these specialities fall. Take a case. Zoology, while it goes on multiplying the number of its species, and getting a more complete knowledge of each species (decreasing generality); also goes on discovering the common characters by which species are united into larger groups (increasing generality). Both these are subjective processes; and in this case, both orders of truth reached are concrete—formulate the phenomena as actually manifested. The truth that mammals of all kinds have seven cervical vertebræ (I believe there is one exception) is a generalisation—a general relation in thought answering to a general relation in things. As the existence of seven cervical vertebræ in each mammal is a concrete fact, the statement of it is a concrete truth, and the statement colligating such truths is not made other than concrete by holding of case after case.

M. Littré, recognizing the necessity for some modification of the hierarchy of the Sciences, as enunciated by M. Comte, still regards it as substantially true; and for proof of its validity, he appeals mainly to the essential *constitutions* of the Sciences. It is unnecessary for me here to meet, in detail, the arguments by which he supports the proposition, that the essential constitutions of the Sciences, justify the order in which M. Comte places them. It will suffice to refer to the foregoing pages, and to the pages which are to follow, as containing the definitions of those fundamental characteristics which demand the grouping of the Sciences in the way I have pointed out. As already shown, and as will be shown still more clearly by and bye, the radical differences of constitution among the Sciences, necessitate the colligation of them into the three classes—Abstract, Abstract-Concrete, and Concrete. How irreconcilable is M. Comte's classification with these groups, will be at once apparent on inspection. It stands thus:—

Mathematics (including rational Mechanics), ...	partly Abstract, partly Abstract-Concrete.
Astronomy	Concrete.
Physics.....	Abstract-Concrete.
Chemistry	Abstract-Concrete.
Biology.....	Concrete.
Sociology.....	Concrete.

asserted (or denied) are of no moment: the propositions of Logic are independent of any qualitative or quantitative specification of the related things. The other sub-division has for its subject-matter, the relations between terms which are specified quantitatively but not qualitatively. The amounts of the related terms, irrespective of their natures, are here dealt with; and Mathematics is a statement of the laws of quantity considered apart from reality. Quantity considered apart from reality, is occupancy of Space or Time; and occupancy of Space or Time is measured by units of one or other order, but of which the ultimate ones are simply separate places in consciousness, either coexistent or sequent. Among units that are unspecified in their natures (extensive, protensive, or intensive), but are ideally endowed with existence considered apart from attributes, the quantitative relations that arise, are those most general relations expressed by numbers. Such relations fall into either of two orders, according as the units are considered simply as capable of filling separate places in consciousness, or according as they are considered as filling places that are not only separate, but equal. In the one case, we have that indefinite calculus by which numbers of abstract existences, but not sums of abstract existence, are predicable. In the other case, we have that definite calculus by which both numbers of abstract existences and sums of abstract existence are predicable. Next comes that division of Mathematics which deals with the quantitative relations of magnitudes (or aggregates of units) considered as coexistent, or as occupying Space—the division called Geometry. And then we arrive at relations, the terms of which include both quantities of Time and quantities of Space—those in which times are estimated by the units of space traversed at a uniform velocity, and those in which equal units of time being given, the spaces traversed with uniform or variable velocities are estimated.

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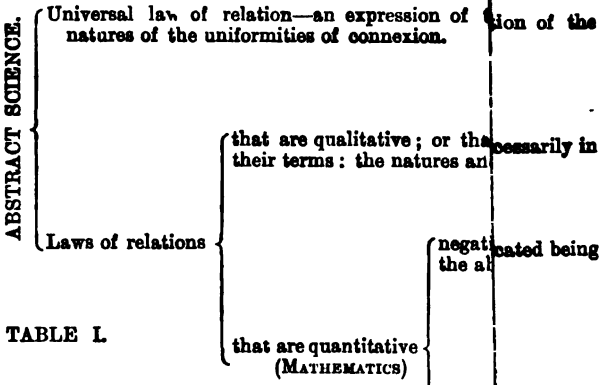

TABLE I.

* This definition includes the laws of relations called necessary, but not those of relations called contingent. These last, in which the probability of an inferred connexion varies with the number of times such connexion has occurred in experience, are rightly dealt with mathematically.

** Here, by way of explanation of the term negatively-quanti
will suffice to instance the proposition that certain three lines
in a point, as a negatively-quantitative proposition; since it as
absence of any quantity of space between their intersections. S
the assertion that certain three points will always fall in a
line, is negatively-quantitative; since the conception of a stra
implies the negation of any lateral quantity, or deviation.

† Lest the meaning of this division should not be underst
name, in illustration, the estimates of the statistician. Calcu
lation, crime, disease, etc., have results which are correct o
in respect of the totalities of being or action represented by th

‡ Perhaps it will be asked—How can there be a Geometry
ception of Force does not enter? The reply is, that the tim
Motion may be considered apart from those of Force, in the sa
of Matter may be considered apart from Matter.

ion of the

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relations.
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indefinite
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Motion.‡)

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These Abstract Sciences, which are concerned exclusively with relations and with the relations of relations, may be grouped as shown in Table I.

Passing from the Sciences concerned with the ideal or unoccupied forms of relations, and turning to the Sciences concerned with real relations, or the relations among realities, we come first to those Sciences which treat of realities, not as they are habitually manifested, but with realities as manifested in their different modes, when these are artificially separated from one another. While the Abstract Sciences are wholly ideal, relatively to the Abstract-Concrete and Concrete Sciences; the Abstract-Concrete Sciences are partially ideal, relatively to the Concrete Sciences. Just as Logic and Mathematics generalize the laws of relation, qualitative and quantitative, apart from related things; so, Mechanics, Physics, Chemistry generalize the laws of relation which different modes of Matter and Motion conform to, when severally disentangled from those actual phenomena in which they are mutually modified. Just as the geometrician formulates the properties of lines and surfaces, independently of the irregularities and thicknesses of lines and surfaces as they really exist; so the physicist and the chemist formulate the manifestations of each mode of force, independently of the disturbances in its manifestations which other modes of force cause in every actual case. In works on Mechanics, the laws of motion are expressed without reference to friction and resistance of the medium. Not what motion ever really is, but what it would be if retarding forces were absent, is asserted. If afterwards any retarding force is taken into account, then the effect of this retarding force is dealt with by itself: neglecting the other retarding forces. Consider, again, the generalizations of the physicist respecting molecular motion. The law that light varies inversely as the square of the distance, is absolutely true only when the radiation

goes on from a point without dimensions, which it never does; and it also assumes that the rays are perfectly straight, which they cannot be unless the medium differs from all actual media in being perfectly homogeneous. If the disturbing effects of changes of media are investigated, the formulæ expressing the refractions take for granted that the new media entered are homogeneous; which they never really are. Even when a compound disturbance is allowed for, as when the refraction undergone by light in traversing a medium of increasing density, like the atmosphere, is calculated, the calculation still supposes conditions that are unnaturally simple—it supposes that the atmosphere is not pervaded by heterogeneous currents, which it always is. Similarly with the inquiries of the chemist. He does not take his substances as Nature supplies them. Before he proceeds to specify their respective properties, he purifies them—separates from each all trace of every other. Before ascertaining the specific gravity of a gas, he has to free this gas from the vapour of water, usually mixed with it. Before describing the properties of a salt, he guards against any error that may arise from the presence of an uncombined portion of the acid or base. And when he alleges of any element that it has a certain atomic weight, and unites with such and such equivalents of other elements, he does not mean that the results thus expressed are exactly the results of any one experiment; but that they are the results which, after averaging many trials, he concludes would be realized if absolute purity could be obtained, and if the experiments could be conducted without loss. His problem is to ascertain the laws of combination of molecules, not as they are actually displayed, but as they would be displayed in the absence of those minute interferences which cannot be altogether avoided. Thus all Abstract-Concrete Sciences have for their object, *analytical interpretation*. In every case it is the aim to decompose the phenomenon, and formulate its

components apart from one another; or some two or three apart from the rest. Wherever, throughout these Sciences, synthesis is employed, it is for the verification of analysis.* The truths elaborated are severally asserted, not as truths exhibited by this or that particular object; but as truths universally holding of Matter and Motion in their more general or more special forms, considered apart from particular objects, and particular places in space.

The sub-divisions of this group of Sciences, may be drawn on the same principle as that on which the sub-divisions of the preceding group were drawn. Phenomena, considered as more or less involved manifestations of force, yield on analysis, certain laws of manifestation which are universal, and other laws of manifestation, which, being dependent on conditions, are not universal. Hence the Abstract-Concrete Sciences are primarily divisible into—the laws of force considered apart from its separate modes, and laws of force considered under each of its separate modes. And this second division of the Abstract-Concrete group, is sub-divisible after a manner essentially analogous. It is needless to occupy space by defining these several

* I am indebted to Prof. Frankland for reminding me of an objection that may be made to this statement. The production of new compounds by synthesis, has of late become an important branch of chemistry. According to certain known laws of composition, complex substances, which never before existed, are formed, and fulfil anticipations both as to their general properties and as to the proportions of their constituents—as proved by analysis. Here it may be said with truth, that analysis is used to verify synthesis. Nevertheless, the exception to the above statement is apparent only,—not real. In so far as the production of new compounds is carried on merely for the obtainment of such new compounds, it is not Science but Art—the application of pre-established knowledge to the achievement of ends. The proceeding is a part of Science, only in so far as it is a means to the better interpretation of the order of Nature. And how does it aid the interpretation? It does it only by verifying the pre-established conclusions respecting the laws of molecular combination; or by serving further to explain them. That is to say, these syntheses, considered on their scientific side, have simply the purpose of *forwarding the analysis of the laws of chemical combination.*

orders and genera of Sciences. Table II. will sufficiently explain their relations.

We come now to the third great group. We have done with the Sciences which are concerned only with the blank forms of relations under which Being is manifested to us. We have left behind the Sciences which, dealing with Being under its universal mode, and its several non-universal modes regarded as independent, treat the terms of its relations as simple and homogeneous, which they never are in Nature. There remain the Sciences which, taking these modes of Being as they are habitually connected with one another, have for the terms of their relations, those heterogeneous combinations of forces that constitute actual phenomena. The subject-matter of these Concrete-Sciences is the real, as contrasted with the wholly or partially ideal. It is their aim, not to separate and generalize apart the components of all phenomena, but to explain each phenomenon as a product of these components. Their relations are not, like those of the simplest Abstract-Concrete Sciences, relations between one antecedent and one consequent; nor are they, like those of the more involved Abstract-Concrete Sciences, relations between some few antecedents cut off in imagination from all others, and some few consequents similarly cut off; but they are relations each of which has for its terms a complete plexus of antecedents and a complete plexus of consequents. This is manifest in the least involved Concrete Sciences. The astronomer seeks to explain the Solar System. He does not stop short after generalizing the laws of planetary movement, such as planetary movement would be did only a single planet exist; but he solves this abstract-concrete problem, as a step towards solving the concrete problem of the planetary movements as affecting one another. In astronomical language, "the theory of the Moon" means an interpretation of the Moon's motions, not as determined simply by centripetal

ABSTRACT-CONCRETE SCIENCE.

Universal laws and composition of forces.

.)

statics.)

ics.)

Dynamics.)

Laws of force manifested by netrability or space-occupancy.

rms resulting from molecular equilibrium.

n, elasticity, etc.) — when solid. / when liquid. / when gaseous.

causing increase of volume (expansion, liquefaction, evaporation).

causing decrease of volume (condensation, solidification, contraction).

producing new relations of molecules (new compounds).

producing new relations of forces (new affinities).

generates sensible motion.

ation, generates / ler the forms of — *Heat.* / *Light.* / *Electricity.* / *Magnetism.*

TABLE II.

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and centrifugal forces, but as perpetually modified by gravitation towards the Earth's equatorial protuberance, towards the Sun, and even towards Venus: forces daily varying in their amounts and combinations. Nor does the astronomer leave off when he has calculated what will be the position of a given body at a given time, allowing for all perturbations; but he goes on to consider the effects produced by reactions on the perturbing masses. And he further goes on to consider how the mutual perturbations of the planets cause, during a long period, increasing deviations from a mean state; and then how compensating perturbations cause continuous decrease of the deviations. That is, the goal towards which he ever strives, is a complete explanation of these complex planetary motions in their totality. Similarly with the geologist. He does not take for his problem only those irregularities of the Earth's crust that are worked by denudation; or only those which igneous action causes. He does not seek simply to understand how sedimentary strata were formed; or how faults were produced; or how moraines originated; or how the beds of Alpine lakes were scooped out. But taking into account all agencies co-operating in endless and ever-varying combinations, he aims to interpret the entire structure of the Earth's crust. If he studies separately the actions of rain, rivers, glaciers, icebergs, tides, waves, volcanoes, earthquakes, etc.; he does so that he may be better able to comprehend their joint actions as factors in geological phenomena: the object of his science being to generalize these phenomena in all their intricate connexions, as parts of one whole. In like manner Biology is the elaboration of a complete theory of Life, in each and all of its involved manifestations. If different aspects of its phenomena are investigated apart—if one observer busies himself in classing organisms, another in dissecting them, another in ascertaining their chemical compositions, another in studying functions, another in tracing laws of modification; they are

dominating integration of matter and dissipation of motion, there goes a change from an indefinite, incoherent homogeneity, to a definite, coherent heterogeneity; and why a reverse re-distribution of matter and motion, is accompanied by a reverse structural change. Passing from this universal Concrete Science, to the non-universal Concrete Sciences: we find that these are primarily divisible into the science which deals with the re-distributions of matter and motion among masses in space, consequent on their mutual actions as wholes; and the science which deals with the re-distributions of matter and motion consequent on the mutual actions of the parts of each mass. And of these equally general Sciences, this last is re-divisible into the Science which is limited to the concomitants of re-distribution among the parts of each mass when regarded as independent, and the Science which takes into account the molecular motion received by radiation from other masses. But these subdivisions, and their sub-sub-divisons, will be best seen in the annexed Table III.

That these great groups of Sciences and their respective sub-groups, fulfil the definition of a true classification given at the outset, is, I think, tolerably manifest. The subjects of inquiry included in each primary division, have essential attributes in common with one another, which they have not in common with any of the subjects contained in the other primary divisions; and they have, by consequence, a greater number of attributes in which they are severally like the subjects they are grouped with, and unlike the subjects otherwise grouped. Between Sciences which deal with relations apart from realities, and Sciences which deal with realities, the distinction is the widest possible; since Being, in some or all of its attributes, is common to all Sciences of the second class, and excluded from all Sciences of the first class. And when we divide the Sciences which treat of realities, into those which deal

CONCRETE SCIENCE.

Un e is a predominant integration of Matter and dissipation
ation of Matter.

universe. (*Sidereal Astronomy.*)

ystem. (*Planetary Astronomy.*)

La
tio
tio mpound molecules. (*Solar Mineralogy.*)

nd genesis of radiant forces.*

and liquids. (*Solar Meteorology.*†)

enerally.

TABLE ition and decomposition of inorganic matters. (*Mineralogy.*)

ibutions of gases and liquids. (*Meteorology.*)

ibutions of solids. (*Geology.*)

phe-
are
- those of structure (*Morphology*)
  - general.
  - special.
- those of function
  - in their internal relations (*Physiology*)
    - general.
    - special.
  - in their external relations (*Psychology*)
    - general
    - special
      - separate.
      - combined. (*Sociology.*‡)

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with their component phenomena considered in ideal separation and those which deal with their component phenomena as actually united, we make a profounder distinction than can exist between the Sciences which deal with one or other order of the components, or than can exist between the Sciences which deal with one or other order of the things composed. The three groups of Sciences may be briefly defined as—laws of the *forms*; laws of the *factors*; laws of the *products*. When thus defined, it becomes manifest that the groups are so radically unlike in their natures, that there can be no transitions between them; and that any Science belonging to one of the groups must be quite incongruous with the Sciences belonging to either of the other groups, if transferred. How fundamental are the differences between them, will be further seen on considering their functions. The first, or abstract group, is *instrumental* with respect to both the others; and the second, or abstract-concrete group is *instrumental* with respect to the third or concrete group. An endeavour to invert these functions will at once show how essential is the difference of character. The second and third groups supply subject-matter to the first, and the third supplies subject-matter to the second; but none of the truths which constitute the third group are of any use as solvents of the problems presented by the second group; and none of the truths which the second group formulates can act as solvents of problems contained in the first group.

Concerning the sub-divisions of these great groups, little remains to be added. That each of the groups, being co-extensive with all phenomena, contains truths that are universal and others that are not universal, and that these must be classed apart, is obvious. And that the sub-divisions of the non-universal truths, are to be made according to their decreasing generality in something like the manner shown in the Tables, is proved by the fact that

when the descriptive words are read from the root to the extremity of any branch, they form a definition of the Science constituting that branch. That the minor divisions might be otherwise arranged, and that better definitions of them might be given, is highly probable. They are here set down merely for the purpose of showing how this method of classification works out.

I will only further remark that the relations of the Sciences as thus represented, are still but imperfectly represented: their relations cannot be truly shown on a plane, but only in space of three dimensions. The three groups cannot rightly be put in linear order as they have here been. Since the first stands related to the third, not only indirectly through the second, but also directly—it is directly instrumental with respect to the third, and the third supplies it directly with subject-matter. Their relations can thus only be truly shown by branches diverging from a common root on different sides, in such a way that each stands in juxta-position to the other two. And only by a like mode of arrangement, can the relations among the sub-divisions of each group be correctly represented.

The foregoing exposition, highly abstract as it is, will by some readers be less readily followed than a more concrete one. With the view of carrying conviction to such I will re-state the case in two ways: the first of them adapted only to those who accept the doctrine of Evolution in its most general form.

We set out with concentrating nebulous matter. Tracing the re-distributions of this, as the rotating contracting spheroid leaves behind successive annuli and as these severally form secondary rotating spheroids, we come at length to planets in their early stages. Thus far we consider the phenomena dealt with purely astronomical; and so long as our Earth, regarded as one of these spheroids,

was made up of gaseous and molten matters only, it presented no data for any more complex Concrete Science. In the lapse of cosmical time a solid film forms, which, in the course of millions of years, thickens, and, in the course of further millions of years, becomes cool enough to permit the precipitation, first of various other gaseous compounds, and finally of water. Presently, the varying exposure of different parts of the spheroid to the Sun's rays, begins to produce appreciable effects; until at length there have arisen meteorological actions, and consequent geological actions, such as those we now know: determined partly by the Sun's heat, partly by the still-retained internal heat of the Earth, and partly by the action of the Moon on the ocean? How have we reached these geological phenomena? When did the astronomical changes end and the geological changes begin? It needs but to ask this question to see that there is no real division between the two. Putting pre-conceptions aside, we find nothing more than a group of phenomena continually complicating under the influence of the same original factors; and we see that our conventional division is defensible only on grounds of convenience. Let us advance a stage. As the Earth's surface continues to cool, passing through all degrees of temperature by infinitesimal gradations, the formation of more and more complex inorganic compounds becomes possible. Later, its surface sinks to that heat at which the less complex compounds of the kinds called organic can exist; and, finally, the formation of the more complex organic compounds takes place. Chemists now show us that these compounds may be built up synthetically in the laboratory —each stage in ascending complexity making possible the next higher stage. Hence it is inferable that, in the myriads of laboratories, endlessly diversified in their materials and conditions, which the Earth's surface furnished during the myriads of years occupied in passing through these stages of temperature, such successive syn-

theses were effected; and that the highly complex unstable substance out of which all organisms are composed, was eventually formed in microscopic portions: from which, by continuous integrations and differentiations, the evolution of all organisms has proceeded. Where then shall we draw the line between Geology and Biology? The synthesis of this most complex compound, is but a continuation of the syntheses by which all simpler compounds were formed. The same primary factors have been co-operating with those secondary factors, meteorologic and geologic, previously derived from them. Nowhere do we find a break in the ever-complicating series; for there is a manifest connexion between those movements which various complex compounds undergo during their isomeric transformations, and those changes of form undergone by the protoplasm which we distinguish as living. Strongly contrasted as they eventually become, biological phenomena are at their root inseparable from geological phenomena—inseparable from the aggregate of transformations continually wrought in the matters forming the Earth's surface by the physical forces to which they are exposed. Further stages I need not particularize. The gradual development out of the biological group of phenomena, of the more specialized group we class as psychological, needs no illustration. And when we come to the highest psychological phenomena, it is clear that since aggregations of human beings may be traced upwards from single wandering families to tribes and nations of all sizes and complexities, we pass insensibly from the phenomena of individual human action to those of corporate human action. To resume, then, is it not manifest that in the group of sciences—Astronomy, Geology, Biology, Psychology, Sociology, we have a natural group that admits neither of disruption nor change of order? Here there is both a genetic dependence, and a dependence of interpretations. The phenomena have arisen in this succession in cosmical

time; and complete scientific interpretation of each group depends on scientific interpretation of the preceding groups. No other science can be thrust in anywhere without destroying the continuity. To insert Physics between Astronomy and Geology, would be to make a break in the history of a continuous series of changes; and a like break would be produced by inserting Chemistry between Geology and Biology. It is true that Physics and Chemistry are needful as interpreters of these successive assemblages of facts; but it does not therefore follow that they are themselves to be placed among these assemblages.

Concrete Science, made up of these five concrete subsciences, being thus coherent within itself, and separated from all other science, there comes the question—Is all other science similarly coherent within itself? or is it traversed by some second division that is equally decided? It is thus traversed. A statical or dynamical theorem, however simple, has always for its subject-matter something that is conceived as extended, and as displaying force or forces—as being a seat of resistance, or of tension, or of both, and as capable of possessing more or less of *vis viva*. If we examine the simplest proposition of Statics, we see that the conception of Force must be joined with the conception of Space, before the proposition can be framed in thought; and if we similarly examine the simplest proposition in Dynamics, we see that Force, Space, and Time, are its essential elements. The amounts of the terms are indifferent; and, by reduction of its terms beyond the limits of perception, they are applied to molecules: Molar Mechanics and Molecular Mechanics are continuous. From questions concerning the relative motions of two or more molecules, Molecular Mechanics passes to changes of aggregation among many molecules, to changes in the amounts and kinds of the motions possessed by them as members of an aggregate, and to changes of the motions transferred through aggregates of them, as those constituting light.

Daily extending its range of interpretations, it is coming to deal even with the components of each compound molecule on the same principles. And the unions and disunions of such more or less compound molecules, which constitute the phenomena of Chemistry, are also being conceived as resultant phenomena of essentially kindred natures—the affinities of molecules for one another, and their reactions in relation to light, heat, and other modes of force, being regarded as consequent on the combinations of the various mechanically-determined motions of their various components. Without at all out-running, however, this progress in the mechanical interpretation of molecular phenomena, it suffices to point out that the indispensable elements in any chemical conception are units occupying places in space, and exerting forces on one another. This, then, is the common character of all these sciences which we at present group under the names of Mechanics, Physics, Chemistry. Leaving undiscussed the question whether it is possible to conceive of force apart from extended somethings exerting it, we may assert, as beyond dispute, that if the conception of force be expelled, no science of Mechanics, Physics, or Chemistry remains. Made coherent, as these sciences are, by this bond of union, it is impossible to thrust among them any other science without breaking their continuity. We cannot place Logic between Molar Mechanics and Molecular Mechanics. We cannot place Mathematics between the group of propositions concerning the behaviour of homogeneous molecules to one another, and the group of propositions concerning the behaviour of heterogeneous molecules to one another (which we call Chemistry). Clearly these two sciences lie outside the coherent whole we have contemplated; separated from it in some radical way.

By what are they radically separated? By the absence of the conception of force through which alone we know objects as existing or acting. However true it may be

that so long as Logic and Mathematics have any terms at all, these must be capable of affecting consciousness, and, by implication, of exerting force; yet it is the distinctive trait of these sciences that not only do their propositions make no reference to such force, but, as far as possible, they deliberately ignore it. Instead of being, as in all the other sciences, an element that is not only recognized but vital; in Mathematics and Logic, force is an element that is not only not vital, but is studiously not recognized. The terms in which Logic expresses its propositions, are symbols that do not profess to represent things, properties, or powers, of one kind more than another; and may equally well stand for the attributes belonging to members of some connected series of ideal curves which have never been drawn, as for so many real objects. And the theorems of Geometry, so far from contemplating perceptible lines and surfaces as elements in the truths enunciated, consider these truths as becoming absolute only when such lines and surfaces become ideal—only when the conception of something exercising force is extruded.

Let me now make a second re-statement, not implying acceptance of the doctrine of Evolution, but exhibiting with a clearness almost if not quite as great, these fundamental distinctions.

The concrete sciences, taken together or separately, contemplate as their subject-matters, *aggregates*—either the entire aggregate of sensible existences, or some secondary aggregate separable from this entire aggregate, or some tertiary aggregate separable from this, and so on. Sidereal Ast onomy occupies itself with the totality of visible masses distributed through space; which it deals with as made up of identifiable individuals occupying specified places, and severally standing towards one another, towards sub-groups, and towards the entire group, in defined ways. Planetary Astronomy, cutting out of this all-including aggregate that

relatively minute part constituting the Solar System, deals with this as a whole—observes, measures, and calculates the sizes, shapes, distances, motions, of its primary, secondary, and tertiary members; and, taking for its larger inquiries the mutual actions of all these members as parts of a co-ordinated assemblage, takes for its smaller inquiries the actions of each member considered as an individual, having a set of intrinsic activities that are modified by a set of extrinsic activities. Restricting itself to one of these aggregates, which admits of close examination, Geology (using this word in its comprehensive meaning) gives an account of terrestrial actions and terrestrial structures, past and present; and, taking for its narrower problems local formations and the agencies to which they are due, takes for its larger problems the serial transformations undergone by the entire Earth. The geologist being occupied with this cosmically small, but otherwise vast, aggregate, the biologist occupies himself with small aggregates formed out of parts of the Earth's superficial substance, and treats each of these as a coordinated whole in its structures and functions; or, when he treats of any particular organ, considers this as a whole made up of parts held in a sub-coordination that refers to the coordination of the entire organism. To the psychologist he leaves those specialized aggregates of functions which adjust the actions of organisms to the complex activities surrounding them: doing this, not simply because they are a stage higher in speciality, but because they are the counterparts of those aggregated states of consciousness dealt with by the science of Subjective Psychology, which stands entirely apart from all other sciences. Finally, the sociologist considers each tribe and nation as an aggregate presenting multitudinous phenomena, simultaneous and successive, that are held together as parts of one combination. Thus, in every case, a concrete science deals with a real aggregate (or a plurality of real aggregates); and it includes as its

subject-matter whatever is to be known of this aggregate in respect of its size, shape, motions, density, texture, general arrangement of parts, minute structure, chemical composition, temperature, etc., together with all the multitudinous changes, material and dynamical, gone through by it from the time it begins to exist as an aggregate to the time it ceases to exist as an aggregate.

No abstract-concrete science makes the remotest attempt to do anything of this sort. Taken together, the abstract-concrete sciences give an account of the various kinds of *properties* which aggregates display; and each abstract-concrete science concerns itself with a certain order of these properties. By this, the properties common to all aggregates are studied and formulated; by that, the properties of aggregates having special forms, special states of aggregation, etc.; and by others, the properties of particular components of aggregates when dissociated from other components. But by all these sciences the aggregate, considered as an individual object, is tacitly ignored; and a property, or a connected set of properties, exclusively occupies attention. It matters not to Mechanics whether the moving mass it considers is a planet or a molecule, a dead stick thrown into the river or the living dog that leaps after it: in any case the curve described by the moving mass conforms to the same laws. Similarly when the physicist takes for his subject the relation between the changing bulk of matter and the changing quantity of molecular motion it contains. Dealing with the subject generally, he leaves out of consideration the kind of matter; and dealing with the subject specially in relation to this or that kind of matter, he ignores the attributes of size and form: save in the still more special cases where the effect on form is considered, and even then size is ignored. So, too, is it with the chemist. A substance he is investigating, never thought of by him as distinguished in extension or amount, is not even required to be perceptible. A portion of carbon on

which he is experimenting, may or may not have been visible under its forms of diamond or graphite or charcoal—this is indifferent. He traces it through various disguises and various combinations—now as united with oxygen to form an invisible gas; now as hidden with other elements in such more complex compounds as ether, and sugar, and oil. By sulphuric acid or other agent he precipitates it from these as a coherent cinder, or as a diffused impalpable powder; and again, by applying heat, forces it to disclose itself as an element of animal tissue. Evidently, while thus ascertaining the affinities and atomic equivalence of carbon, the chemist has nothing to do with any aggregate. He deals with carbon in the abstract, as something considered apart from quantity, form, appearance, or temporary state of combination; and conceives it as the possessor of powers or properties, whence the special phenomena he describes result: the ascertaining of all these powers or properties being his sole aim.

Finally, the Abstract Sciences ignore alike aggregates and the powers which aggregates or their components possess; and occupy themselves with *relations*—either with the relations among aggregates, or among their parts, or the relations among aggregates and properties, or the relations among properties, or the relations among relations. The same logical formula applies equally well, whether its terms are men and their deaths, crystals and their planes of cleavage, or plants and their seeds. And how entirely Mathematics concerns itself with relations, we see on remembering that it has just the same expression for the characters of an infinitesimal triangle, as for those of the triangle which has Sirius for its apex and the diameter of the Earth's orbit for its base.

I cannot see how these definitions of these groups of sciences can be questioned. It is undeniable that every Concrete Science gives an account of an aggregate or of aggregates, inorganic, organic, or super-organic (a society);

and that, not concerning itself with properties of this or that order, it concerns itself with the co-ordination of the assembled properties of all orders. It seems to me no less certain that an Abstract-Concrete Science gives an account of some order of properties, general or special; not caring about the other traits of an aggregate displaying them, and not recognizing aggregates at all further than is implied by discussion of the particular order of properties. And I think it is equally clear that an Abstract Science, freeing its propositions, so far as the nature of thought permits, from aggregates and properties, occupies itself with relations of co-existence and sequence, as disentangled from all particular forms of being and action. If then these three groups of sciences are, respectively, accounts of *aggregates*, accounts of *properties*, accounts of *relations*, it is manifest that the divisions between them are not simply perfectly clear, but that the chasms between them are absolute.

Here, perhaps more clearly than before, will be seen the untenability of the classification made by M. Comte. Already, after setting forth in a general way these fundamental distinctions, I have pointed out the incongruities that arise when the sciences, conceived as Abstract, Abstract-Concrete, and Concrete, are arranged in the order proposed by him. Such incongruities become still more conspicuous if for these general names of the groups we substitute the definitions given above. The series will then stand thus:—

MATHEMATICS.....An account of *relations*
(including, under Mechanics, an account of *properties*).
ASTRONOMY .....An account of *aggregates*.
PHYSICS .....An account of *properties*.
CHEMISTRY.....An account of *properties*.
BIOLOGY .....An account of *aggregates*.
SOCIOLOGY .....An account of *aggregates*.

That those who espouse opposite views see clearly the

defects in the propositions of their opponents and not those in their own, is a trite remark that holds in philosophical discussions as in all others: the parable of the mote and the beam applies as well to men's appreciations of one another's opinions as to their appreciations of one another's natures. Possibly to my positivist friends I exemplify this truth,—just as they exemplify it to me. Those uncommitted to either view must decide where the mote exists and where the beam. Meanwhile it is clear that one or other of the two views is essentially erroneous; and that no qualifications can bring them into harmony. Either the sciences admit of no such grouping as that which I have described, or they admit of no such serial order as that given by M. Comte.

Postscript Replying to Criticisms.

Among objections made to any doctrine, those which come from avowed supporters of an adverse doctrine must be considered, other things equal, as of less weight than those which come from men uncommitted to an adverse doctrine, or but partially committed to it. The element of prepossession, distinctly present in the one case and in the other case mainly or quite absent, is a well-recognized cause of difference in the values of the judgments: supposing the judgments to be otherwise fairly comparable. Hence, when it is needful to bring the replies within a restricted space, a fit course is that of dealing rather with independent criticisms than with criticisms which are really indirect arguments for an opposite view, previously espoused.

For this reason I propose here to confine myself substantially, though not absolutely, to the demurrers entered against the foregoing classification by Prof. Bain, in his recent work on Logic. Before dealing with the more

important of these, let me clear the ground by disposing of the less important.

Incidentally, while commenting on the view I take respecting the position of Logic, Prof. Bain points out that this, which is the most abstract of the sciences, owes much to Psychology, which I place among the Concrete Sciences; and he alleges an incongruity between this fact and my statement that the Concrete Sciences are not instrumental in disclosing the truths of the Abstract Sciences. Subsequently he re-raises this apparent anomaly when saying—

"Nor is it possible to justify the placing of Psychology wholly among Concrete Sciences. It is a highly analytic science, as Mr. Spencer thoroughly knows."

For a full reply, given by implication, I must refer Prof. Bain to § 56 of *The Principles of Psychology*, where I have contended that "while, under its objective aspect, Psychology is to be classed as one of the Concrete Sciences which successively decrease in scope as they increase in speciality; under its subjective aspect, Psychology is a totally unique science, independent of, and antithetically opposed to, all other sciences whatever." A pure idealist will not, I suppose, recognize this distinction; but to every one else it must, I should think, be obvious that the science of subjective existences is the correlative of all the sciences of objective existences; and is as absolutely marked off from them as subject is from object. Objective Psychology, which I class among the Concrete Sciences, is purely synthetic, so long as it is limited, like the other sciences, to objective data; though great aid in the interpretation of these data is derived from the observed correspondence between the phenomena of Objective Psychology as presented in other beings and the phenomena of Subjective Psychology as presented in one's own consciousness. Now it is Subjective Psychology only which is analytic, and which affords aid in the

development of Logic. This being explained, the apparent incongruity disappears.

A difficulty raised respecting the manner in which I have expressed the nature of Mathematics, may next be dealt with. Prof. Bain writes:—

"In the first place, objection may be taken to his language, in discussing the extreme Abstract Sciences, when he speaks of the *empty forms* therein considered. To call Space and Time empty forms, must mean that they can be thought of without any concrete embodiment whatsoever; that one can think of Time, as a pure abstraction, without having in one's mind any concrete succession. Now, this doctrine is in the last degree questionable."

I quite agree with Prof. Bain that "this doctrine is in the last degree questionable;" but I do not admit that this doctrine is implied by the definition of Abstract Science which I have given. I speak of Space and Time as they are dealt with by mathematicians, and as it is alone possible for pure Mathematics to deal with them. While Mathematics habitually uses in its points, lines, and surfaces, certain existences, it habitually deals with these as representing points, lines, and surfaces that are ideal; and *its conclusions are true only on condition that it does this.* Points having dimensions, lines having breadths, planes having thicknesses, are negatived by its definitions. Using, though it does, material representatives of extension, linear, superficial, or solid, Geometry deliberately ignores their materiality; and attends only to the truths of relation they present. Holding with Prof. Bain, as I do, that our consciousness of Space is disclosed by our experiences of Matter—arguing, as I have done in *The Principles of Psychology,* that it is a consolidated aggregate of all relations of co-existence that have been severally presented by Matter; I nevertheless contend that it is possible to dissociate these relations from Matter to the extent required for formulating them as abstract truths. I contend, too, that this separation is of the kind habitually made in other cases; as, for instance, when the general laws of motion are formulated (as M. Comte's system, among

others, formulates them) in such way as to ignore all properties of the bodies dealt with save their powers of taking up, and retaining, and giving out, quantities of motion; though these powers are inconceivable apart from the attribute of extension, which is intentionally disregarded.

Taking other of Prof. Bain's objections, not in the order in which they stand but in the order in which they may be most conveniently dealt with, I quote as follows:—

"The law of the radiation of light (the inverse square of the distance) is said by Mr. Spencer to be Abstract-Concrete, while the disturbing changes in the medium are not to be mentioned except in a Concrete Science of Optics. We need not remark that such a separate handling is unknown to science."

It is perfectly true that "such a separate handling is unknown to science." But, unfortunately for the objection, it is also perfectly true that no such separate handling is proposed by me, or is implied by my classification. How Prof. Bain can have so missed the meaning of the word "concrete," as I have used it, I do not understand. After pointing out that "no one ever drew the line," between the Abstract-Concrete and the Concrete Sciences, "as I have done it," he alleges an anomaly which exists only supposing that I have drawn it where it is ordinarily drawn. He appears inadvertently to have carried with him M. Comte's conception of Optics as a Concrete Science, and, importing it into my classification, debits me with the incongruity. If he will re-read the definition of the Abstract-Concrete Sciences, or study their sub-divisions as shown in Table II., he will, I think, see that the most special laws of the redistribution of light, equally with its most general laws, are included. And if he will pass to the definition and the tabulation of the Concrete Sciences, he will, I think, see no less clearly that Optics cannot be included among them.

Prof. Bain considers that I am not justified in classing Chemistry as an Abstract-Concrete Science, and excluding from it all consideration of the crude forms of the various

substances dealt with; and he enforces his dissent by saying that chemists habitually describe the ores and impure mixtures in which the elements, etc., are naturally found. Undoubtedly chemists do this. But do they therefore intend to include an account of the ores of a substance, *as a part of the science* which formulates its molecular constitution and the constitutions of all the definite compounds it enters into? I shall be very much surprised if I find that they do. Chemists habitually prefix to their works a division treating of Molecular Physics; but they do not therefore claim Molecular Physics as a part of Chemistry. If they similarly prefix to the chemistry of each substance an outline of its mineralogy, I do not think they therefore mean to assert that the last belongs to the first. Chemistry proper, embraces nothing beyond an account of the constitutions and modes of action and combining proportions of substances that are taken as absolutely pure; and its truths no more recognize impure substances than the truths of Geometry recognize crooked lines.

Immediately after, in criticizing the fundamental distinction I have made between Chemistry and Biology, as Abstract-Concrete and Concrete respectively, Prof. Bain says:—

"But the objects of Chemistry and the objects of Biology are equally concrete, so far as they go; the simple bodies of chemistry, and their several compounds, are viewed by the Chemist as concrete wholes, and are described by him, not with reference to one factor, but to all their factors."

Issue is here raised in a form convenient for elucidation of the general question. It is true that, *for purposes of identification*, a chemist gives an account of all the sensible characters of a substance. He sets down its crystalline form, its specific gravity, its power of refracting light, its behaviour as magnetic or diamagnetic. But does he thereby include these phenomena as part of the Science of Chemistry? It seems to me that the relation between the weight

of any portion of matter and its bulk, which is ascertained on measuring its specific gravity, is a physical and not a chemical fact. I think, too, that the physicist will claim, as part of his science, all investigations touching the refraction of light: be the substance producing this refraction what it may. And the circumstance that the chemist may test the magnetic or diamagnetic property of a body, as a means of ascertaining what it is, or as a means of helping other chemists to determine whether they have got before them the same body, will neither be held by the chemist, nor allowed by the physicist, to imply a transfer of magnetic phenomena from the domain of the one to that of the other. In brief, though the chemist, in his account of an element or a compound, may refer to certain physical traits associated with its molecular constitution and affinities, he does not by so doing change these into chemical traits. Whatever chemists may put into their books, Chemistry, considered as a science, includes only the phenomena of molecular structures and changes—of compositions and decompositions.* I contend, then, that Chemistry does *not* give an account of anything as a concrete whole, in the same way that Biology gives an account of an organism as a concrete whole. This will become even more manifest on observing the character of

* Perhaps some will say that such incidental phenomena as those of the heat and light evolved during chemical changes, are to be included among chemical phenomena. I think, however, the physicist will hold that all phenomena of re-distributed molecular motion, no matter how arising, come within the range of Physics. But whatever difficulty there may be in drawing the line between Physics and Chemistry (and, as I have incidentally pointed out in *The Principles of Psychology*, § 55, the two are closely linked by the phenomena of allotropy and isomerism), applies equally to the Comtean classification, or to any other. And I may further point out that no obstacle hence arises to the classification I am defending. Physics and Chemistry being both grouped by me as Abstract-Concrete Sciences, no difficulty in satisfactorily dividing them in the least affects the satisfactoriness of the division of the great group to which they both belong, from the other two great groups.

the biological account. All the attributes of an organism are comprehended, from the most general to the most special—from its conspicuous structural traits to its hidden and faint ones; from its outer actions that thrust themselves on the attention, to the minutest sub-divisions of its multitudinous internal functions; from its character as a germ, through the many changes of size, form, organization, and habit, it goes through until death; from the physical characters of it as a whole, to the physical characters of its microscopic cells, and vessels, and fibres; from the chemical characters of its substance in general to the chemical characters of each tissue and each secretion—all these, with many others. And not only so, but there is comprehended as the ideal goal of the science, the *consensus* of all these phenomena in their co-existences and successions, as constituting a coherent individualized group definitely combined in space and in time. It is this recognition of *individuality* in its subject-matter, that gives its concreteness to Biology, as to every other Concrete Science. As Astronomy deals with bodies that have their several proper names, or (as with the smaller stars) are registered by their positions, and considers each of them as a distinct individual—as Geology, while dimly perceiving in the Moon and nearest planets other groups of geological phenomena (which it would deal with as independent wholes, did not distance forbid), occupies itself with that individualized group presented by the Earth; so Biology treats either of an individual distinguished from all others, or of parts or products belonging to such an individual, or of structural or functional traits common to many such individuals that have been observed, and supposed to be common to others that are like them in most or all of their attributes. Every biological truth connotes a specifically individualized object, or a number of specifically individualized objects of the same kind, or numbers of different kinds that are severally specific. See, then, the contrast

The truths of the Abstract-Concrete Sciences do not imply specific individuality. Neither Molar Physics, nor Molecular Physics, nor Chemistry, concerns itself with this. The laws of motion are expressed without any reference whatever to the sizes or shapes of the moving masses; which may be taken indifferently to be suns or atoms. The relations between contraction and the escape of molecular motion, and between expansion and the absorption of molecular motion, are expressed in their general forms without reference to the kind of matter; and, if the degree of either that occurs in a particular kind of matter is formulated, no note is taken of the quantity of that matter, much less of its individuality. Similarly with Chemistry. When it inquires into the atomic weight, the molecular structure, the atomicity, the combining proportions, etc., of a substance, it is indifferent whether a grain or a ton be thought of—the conception of amount is absolutely irrelevant. And so with more special attributes. Sulphur, considered chemically, is not sulphur under its crystalline form, or under its allotropic viscid form, or as a liquid, or as a gas; but it is sulphur considered apart from those attributes of quantity, and shape, and state, that give individuality.

Prof. Bain objects to the division I have drawn between the Concrete Science of Astronomy and that Abstract-Concrete Science which deals with the mutually-modified motions of hypothetical masses in space, as "not a little arbitrary." He says:—

"We can suppose a science to confine itself *solely* to the 'factors,' or the separated elements, and never, on any occasion, to combine two into a composite third. This position is intelligible, and possibly defensible. For example, in Astronomy, the Law of Persistence of Motion in a straight line might be discussed in pure ideal separation; and so, the Law of Gravity might be discussed in equally pure separation—both under the Abstract-Concrete department of Mechanics. It might then be reserved to a *concrete* department to unite these in the explanation of a projectile or of a planet. Such, however, is not Mr. Spencer's boundary line. He allows Theoretical Mechanics to make this particular combination, and to arrive at the laws of

planetary movement, *in the case of a single planet.* What he does not allow is, to proceed to the case of two planets, mutually disturbing one another, or a planet and a satellite, commonly called the 'problem of the Three Bodies.'"

If I held what Prof. Bain supposes me to hold, my position would be an absurd one; but he misapprehends me. The misapprehension results in part from his having here, as before, used the word "concrete" with the Comtean meaning, as though it were my meaning; and in part from the inadequacy of my explanation. I did not in the least mean to imply that the Abstract-Concrete Science of Mechanics, when dealing with the motions of bodies in space, is limited to the interpretation of planetary movement such as it would be did only a single planet exist. It never occurred to me that my words might be so construed. Abstract-Concrete problems admit, in fact, of being complicated indefinitely, without going in the least beyond the definition. I do not draw the line, as Prof. Bain alleges, between the combination of two factors and the combination of three, or between the combination of any number and any greater number. I draw the line between the science which deals with the theory of the factors, taken singly and in combinations of two, three, four, or more, and the science which, *giving to these factors the values derived from observations of actual objects, uses the theory to explain actual phenomena.*

It is true that, in these departments of science, no radical distinction is consistently recognized between theory and the applications of theory. As Prof. Bain says:—

"Newton, in the First Book of the Principia, took up the problem of the Three Bodies, as applied to the Moon, and worked it to exhaustion. So writers on Theoretical Mechanics continue to include the Three Bodies, Precession, and the Tides."

But, supreme though the authority of Newton may be as a mathematician and astronomer, and weighty as are the names of Laplace and Herschel, who in their works have similarly mingled theorems and the explanations yielded by them, it does not seem to me that these facts go for much;

unless it can be shown that these writers intended thus to enunciate the views at which they had arrived respecting the classification of the sciences. Such a union as that presented in their works, adopted merely for the sake of convenience, is, in fact, the indication of incomplete development; and has been paralleled in simpler sciences which have afterwards outgrown it. Two conclusive illustrations are at hand. The name Geometry, utterly inapplicable by its meaning to the science as it now exists, was applicable in that first stage during which its few truths were taught in preparation for land-measuring and the setting-out of buildings; but, at a comparatively early date, these comparatively simple truths became separated from their applications, and were embodied by the Greek geometers into systems of theory.* A like purification is now taking place in another division of the science. In the *Géométrie Descriptive* of Monge, theorems were mixed with their applications to projection and plan-drawing. But, since his time, the science and the art have been segregating; and Descriptive Geometry, or, as it may be better termed, the Geometry of Position, is now recognized by mathematicians as a far-reaching system of truths, parts of which are already embodied in books that make no reference to derived methods available by the architect or the engineer. To meet a counter-illustration that will be cited, I may remark that though, in works on Algebra intended for beginners, the theories of quantitative relations, as treated algebraically, are accompanied by groups of problems to be solved, the subject-matters of these problems are not thereby made parts of the Science of Algebra. To say that they are, is to say that Algebra includes the conceptions of distances and relative speeds and times, or of weights and bulks and

* It may be said that the mingling of problems and theorems in Euclid is not quite consistent with this statement; and it is true that we have, in this mingling, a trace of the earlier form of the science. But it is to be remarked that these problems are all purely abstract, and, further, that each of them admits of being expressed as a theorem.

specific gravities, or of areas ploughed and days and wages; since these, and endless others, may be the terms of its equations. And just in the same way that these concrete problems, solved by its aid, cannot be incorporated with the Abstract Science of Algebra; so I contend that the concrete problems of Astronomy, cannot be incorporated with that division of Abstract-Concrete Science which develops the theory of the inter-actions of free bodies that attract one another.

On this point I find myself at issue, not only with Prof. Bain, but also with Mr. Mill, who contends that:—

"There *is* an abstract science of astronomy, namely, the theory of gravitation, which would equally agree with and explain the facts of a totally different solar system from the one of which our earth forms a part. The actual facts of our own system, the dimensions, distances, velocities, temperatures, physical constitution, etc., of the sun, earth, and planets, are properly the subject of a concrete science, similar to natural history; but the concrete is more inseparably united to the abstract science than in any other case, since the few celestial facts really accessible to us are nearly all required for discovering and proving the law of gravitation as an universal property of bodies, and have therefore an indispensable place in the abstract science as its fundamental data."—*Auguste Comte and Positivism*, p. 43.

In this explanation, Mr. Mill recognizes the fundamental distinction between the Concrete Science of Astronomy, dealing with the bodies actually distributed in space, and a science dealing with hypothetical bodies hypothetically distributed in space. Nevertheless, he regards these sciences as not separable; because the second derives from the first the data whence the law of inter-action is derived. But the truth of this premiss, and the legitimacy of this inference, may alike be questioned. The discovery of the law of inter-action was not due primarily, but only secondarily, to observation of the heavenly bodies. The conception of an inter-acting force that varies inversely as the square of the distance, is an *a priori* conception rationally deducible from mechanical and geometrical considerations. Though unlike in derivation to the many empirical hypotheses of Kepler respecting planetary orbits and planetary motions, yet it was

like the successful among these in its relation to astronomical phenomena: it was one of many possible hypotheses, which admitted of having their consequences worked out and tested; and one which, on having its implications compared with the results of observation, was found to explain them. In short, the theory of gravitation grew out of experiences of terrestrial phenomena; but the verification of it was reached through experiences of celestial phenomena. Passing now from premiss to inference, I do not see that, even were the alleged parentage substantiated, it would necessitate the supposed inseparability; any more than the descent of Geometry from land-measuring necessitates a persistent union of the two. In the case of Algebra, as above indicated, the disclosed laws of quantitative relations hold throughout multitudinous orders of phenomena that are extremely heterogeneous; and this makes conspicuous the distinction between the theory and its applications. Here the laws of quantitative relations among masses, distances, velocities, and momenta, being applied mainly (though not exclusively) to the concrete cases presented by Astronomy, the distinction between the theory and its applications is less conspicuous. But, intrinsically, it is as great in the one case as in the other.

How great it is, we shall see on taking an analogy. This is a living man, of whom we may know little more than that he is a visible, tangible person; or of whom we may know enough to form a voluminous biography. Again, this book tells of a fictitious hero, who, like the heroes of old romance, may be an impersonated virtue or vice, or, like a modern hero, one of mixed nature, whose various motives and consequent actions are elaborated into a semblance of reality. But no accuracy and completeness of the picture makes this fictitious personage an actual personage, or brings him any nearer to one. Nor does any meagreness in our knowledge of a real man reduce him any nearer to the imaginary being of a novel. To the

last, the division between fiction and biography remains an impassable gulf. So, too, remains the division between the Science dealing with the inter-actions of hypothetical bodies in space, and the Science dealing with the inter-actions of existing bodies in space. We may elaborate the first to any degree whatever by the introduction of three, four, or any greater number of factors under any number of assumed conditions, until we symbolize a solar system; but to the last an account of our symbolic solar system is as far from an account of the actual solar system as fiction is from biography.

Even more obvious, if it be possible, does the radical character of this distinction become, on observing that from the simplest proposition of General Mechanics we may pass to the most complex proposition of Celestial Mechanics, without a break. We take a body moving at a uniform velocity, and commence with the proposition that it will continue so to move for ever. Next, we state the law of its accelerated motion in the same line, when subject to a uniform force. We further complicate the proposition by supposing the force to increase in consequence of approach towards an attracting body; and we may formulate a series of laws of acceleration, resulting from so many assumed laws of increasing attraction (of which the law of gravitation is one). Another factor may now be added by supposing the body to have motion in a direction other than that of the attracting body; and we may determine, according to the ratios of the supposed forces, whether its course will be hyperbolic, parabolic, elliptical, or circular—we may begin with this hypothetical additional force as infinitesimal, and formulate the varying results as it is little by little increased. The problem is complicated a degree more by taking into account the effects of a third force, acting in some other direction; and beginning with an infinitesimal amount of this force we may reach any amount. Similarly, by introducing factor after factor,

each at first insensible in proportion to the rest, we arrive, through an infinity of gradations, at a combination of any complexity.

Thus, then, the Science which deals with the inter-action of hypothetical bodies in space, is *absolutely continuous* with General Mechanics. We have already seen that it is *absolutely discontinuous* with that account of the heavenly bodies which has been called Astronomy from the beginning. When these facts are recognized, it seems to me that there cannot remain a doubt respecting its true place in a classification of the Sciences.

REASONS FOR DISSENTING FROM THE PHILOSOPHY OF M. COMTE.

[*Originally published in April* 1864 *as an appendix to the foregoing essay.*]

WHILE the preceding pages were passing through the press, there appeared in the *Revue des Deux Mondes* for February 15th, 1864, an article on a late work of mine—*First Principles*. To M. Auguste Laugel, the writer of the article, I am much indebted for the careful exposition he has made of some of the leading views set forth in that work; and for the catholic and sympathetic spirit in which he has dealt with them. In one respect, however, M. Laugel conveys to his readers an erroneous impression—an impression doubtless derived from what appears to him adequate evidence, and doubtless expressed in perfect sincerity. M. Laugel describes me as being, in part, a follower of M. Comte. After describing the influence of M. Comte as traceable in the works of some other English writers, naming especially Mr. Mill and Mr. Buckle, he goes on to say that this influence, though not avowed, is easily recognizable in the work he is about to make known; and in several places throughout his review, there are remarks having the same implication. I greatly regret having to take exception to anything said by a critic so candid and so able. But the *Revue des Deux Mondes*

circulates widely in England, as well as elsewhere; and finding that there exists in some minds, both here and in America, an impression similar to that entertained by M. Laugel—an impression likely to be confirmed by his statement—it appears to me needful to meet it.

Two causes of quite different kinds, have conspired to diffuse the erroneous belief that M. Comte is an accepted exponent of scientific opinion. His bitterest foes and his closest friends, have unconsciously joined in propagating it. On the one hand, M. Comte having designated by the term "Positive Philosophy" all that definitely-established knowledge which men of science have been gradually organizing into a coherent body of doctrine; and having habitually placed this in opposition to the incoherent body of doctrine defended by theologians; it has become the habit of the theological party to think of the antagonist scientific party, under the title of "positivists." And thus, from the habit of calling them "positivists," there has grown up the assumption that they call themselves "positivists," and that they are disciples of M. Comte. On the other hand, those who have accepted M. Comte's system, and believe it to be the philosophy of the future, have naturally been prone to see everywhere the signs of its progress; and wherever they have found opinions in harmony with it, have ascribed these opinions to the influence of its originator. It is always the tendency of discipleship to magnify the effects of the master's teachings; and to credit the master with all the doctrines he teaches. In the minds of his followers, M. Comte's name is associated with scientific thinking, which, in many cases, they first understood from his exposition of it. Influenced as they inevitably are by this association of ideas, they are reminded of M. Comte wherever they meet with thinking which corresponds, in some marked way, to M. Comte's description of scientific thinking; and hence are apt to imagine him as introducing into other minds, the concep-

tions which he introduced into their minds. Such impressions are, however, in most cases quite unwarranted. That M. Comte has given a general exposition of the doctrine and method elaborated by Science, is true. But it is not true that the holders of this doctrine and followers of this method, are disciples of M. Comte. Neither their modes of inquiry nor their views concerning human knowledge in its nature and limits, are appreciably different from what they were before. If they are "positivists," it is in the sense that all men of science have been more or less consistently "positivists;" and the applicability of M. Comte's title to them, no more makes them his disciples, than does its applicability to men of science who lived and died before M. Comte wrote, make these his disciples. M. Comte himself by no means claims that which some of his adherents are apt, by implication, to claim for him. He says:—"Il y a, sans doute, beaucoup d'analogie entre ma *philosophie positive* et ce que les savans anglais entendent, depuis Newton surtout, par *philosophie naturelle;*" (see *Avertissement*) and further on he indicates the "grand mouvement imprimé à l'esprit humain, il y a deux siècles, par l'action combinée des préceptes de Bacon, des conceptions de Descartes, et des découvertes de Galilée, comme le moment où l'esprit de la philosophie positive a commencé à se prononcer dans le monde." That is to say, the general mode of thought and way of interpreting phenomena, which M. Comte calls "Positive Philosophy," he recognizes as having been growing for two centuries; as having reached, when he wrote, a marked development; and as being the heritage of all men of science.

That which M. Comte proposed to do, was to give scientific thought and method a more definite embodiment and organization; and to apply it to the interpretation of classes of phenomena not previously dealt with in a scientific manner. The conception was a great one; and the endeavour to work it out was worthy of sympathy and

applause. Some such conception was entertained by Bacon. He, too, aimed at the organization of the sciences; he, too, held that "Physics is the mother of all the sciences;" he, too, held that the sciences can be advanced only by combining them, and saw the nature of the required combination; he, too, held that moral and civil philosophy could not flourish when separated from their roots in natural philosophy; and thus he, too, had some idea of a social science growing out of physical science. But the state of knowledge in his day prevented any advance beyond the general conception: indeed, it was marvellous that he should have advanced so far. Instead of a vague, undefined conception, M. Comte has presented the world with a defined and highly-elaborated conception. In working out this conception he has shown remarkable breadth of view, great originality, immense fertility of thought, unusual powers of generalization. Considered apart from the question of its truth, his system of Positive Philosophy is a vast achievement. But after according to M. Comte high admiration for his conception, for his effort to realize it, and for the faculty he has shown in the effort to realize it, there remains the inquiry—Has he succeeded? A thinker who re-organizes the scientific method and knowledge of his age, and whose re-organization is accepted by his successors, may rightly be said to have such successors for his disciples. But successors who accept this method and knowledge of his age, *minus* his re-organization, are certainly not his disciples. How then stands the case with M. Comte? There are some few who receive his doctrines with but little reservation; and these are his disciples truly so called. There are others who regard with approval certain of his leading doctrines, but not the rest: these we may distinguish as partial adherents. There are others who reject all his distinctive doctrines; and these must be classed as his antagonists. The members of this class stand substantially in the same position as they would

have done had he not written. Declining his re-organization of scientific doctrine, they possess this scientific doctrine in its pre-existing state, as the common heritage bequeathed by the past to the present; and their adhesion to this scientific doctrine in no sense implicates them with M. Comte. In this class stand the great body of men of science. And in this class I stand myself.

Coming thus to the personal part of the question, let me first specify those great general principles on which M. Comte is at one with preceding thinkers; and on which I am at one with M. Comte.

All knowledge is from experience, holds M. Comte; and this I also hold—hold it, indeed, in a wider sense than M. Comte; since, not only do I believe that all the ideas acquired by individuals, and consequently all the ideas transmitted by past generations, are thus derived; but I also contend that the very faculties by which they are acquired, are the products of accumulated and organized experiences received by ancestral races of beings (see *Principles of Psychology*). But the doctrine that all knowledge is from experience, is not originated by M. Comte; nor is it claimed by him. He himself says—"Tous les bons esprits répètent, depuis Bacon, qu'il n'y a de connaissances réelles que celles qui reposent sur des faits observés." And the elaboration and definite establishment of this doctrine, has been the special characteristic of the English school of Psychology. Nor am I aware that M. Comte, accepting this doctrine, has done anything to make it more certain, or give it greater definiteness. Indeed it was impossible for him to do so; since he repudiates that part of mental science by which alone this doctrine can be proved.

It is a further belief of M. Comte, that all knowledge is phenomenal or relative; and in this belief I entirely agree. But no one alleges that the relativity of all knowledge was first enunciated by M. Comte. Among others who have

more or less consistently held this truth, Sir William Hamilton enumerates, Protagoras, Aristotle, St. Augustin, Boethius, Averroes, Albertus Magnus, Gerson, Leo Hebræus, Melancthon, Scaliger, Francis Piccolomini, Giordano Bruno, Campanella, Bacon, Spinoza, Newton, Kant. And Sir William Hamilton, in his "Philosophy of the Unconditioned," first published in 1829, has given a scientific demonstration of this belief. Receiving it in common with other thinkers, from preceding thinkers, M. Comte has not, to my knowledge, advanced this belief. Nor indeed could he advance it, for the reason already given—he denies the possibility of that analysis of thought which discloses the relativity of all cognition.

M. Comte reprobates the interpretation of different classes of phenomena by assigning metaphysical entities as their causes; and I coincide in the opinion that the assumption of such separate entities, though convenient, if not indeed necessary, for purposes of thought, is, scientifically considered, illegitimate. This opinion is, in fact, a corollary from the last; and must stand or fall with it. But like the last it has been held with more or less consistency for generations. M. Comte himself quotes Newton's favorite saying—"O! Physics, beware of Metaphysics!" Neither to this doctrine, any more than to the preceding doctrines, has M. Comte given a firmer basis. He has simply reasserted it; and it was out of the question for him to do more. In this case, as in the others, his denial of subjective psychology debarred him from proving that these metaphysical entities are mere symbolic conceptions which do not admit of verification.

Lastly, M. Comte believes in invariable natural laws—absolute uniformities of relation among phenomena. But very many before him have believed in them too. Long familiar even beyond the bounds of the scientific world, the proposition that there is an unchanging order in things, has, within the scientific world, held, for generations, the

position of an established postulate: by some men of science recognized only as holding of inorganic phenomena; but recognized by other men of science, as universal. And M. Comte, accepting this doctrine from the past, has left it substantially as it was. Though he has asserted new uniformities, I do not think scientific men will admit that he has so demonstrated them, as to make the induction more certain; nor has he deductively established the doctrine, by showing that uniformity of relation is a necessary corollary from the persistence of force, as may readily be shown.

These, then, are the pre-established general truths with which M. Comte sets out—truths which cannot be regarded as distinctive of his philosophy. "But why," it will perhaps be asked, "is it needful to point out this; seeing that no instructed reader supposes these truths to be peculiar to M. Comte?" I reply that though no disciple of M. Comte would deliberately claim them for him; and though no theological antagonist at all familiar with science and philosophy, supposes M. Comte to be the first propounder of them; yet there is so strong a tendency to associate any doctrines with the name of a conspicuous recent exponent of them, that false impressions are produced, even in spite of better knowledge. Of the need for making this reclamation, definite proof is at hand. In the No. of the *Revue des Deux Mondes* named at the commencement, may be found, on p. 936, the words—"Toute religion, comme toute philosophie, a la prétention de donner une explication de l'univers. La philosophie qui s'appelle *positive* se distingue de toutes les philosophies et de toutes les religions en ce qu'elle a renoncé à cette ambition de l'esprit humain;" and the remainder of the paragraph is devoted to explaining the doctrine of the relativity of knowledge. The next paragraph begins—"Tout imbu de ces idées, que nous exposons sans les discuter pour le moment, M. Spencer divise, etc." Now this is one of those collocations of ideas

which tends to create, or to strengthen, the erroneous impression I would dissipate. I do not for a moment suppose that M. Laugel intended to say that these ideas which he describes as ideas of the "Positive Philosophy," are peculiarly the ideas of M. Comte. But little as he probably intended it, his expressions suggest this conception. In the minds of both disciples and antagonists, "the Positive Philosophy" means the philosophy of M. Comte; and to be imbued with the ideas of "the Positive Philosophy" means to be imbued with the ideas of M. Comte—to have received these ideas from M. Comte. After what has been said above, I need scarcely repeat that the conception thus inadvertently suggested, is a wrong one. M. Comte's brief enunciations of these general truths, gave me no clearer apprehensions of them than I had before. Such clarifications of ideas on these ultimate questions, as I can trace to any particular teacher, I owe to Sir William Hamilton.

From the principles which M. Comte held in common with many preceding and contemporary thinkers, let us pass now to the principles that are distinctive of his system. Just as entirely as I agree with M. Comte on those cardinal doctrines which we jointly inherit; so entirely do I disagree with him on those cardinal doctrines which he propounds, and which determine the organization of his philosophy. The best way of showing this will be to compare, side by side, the—

Propositions held by M. Comte.	*Propositions which I hold.*
"... chacune de nos conceptions principales, chaque branche de nos connaissances, passe successivement par trois états théoriques différens: l'état théologique, ou fictif; l'état métaphysique, ou abstrait; l'état scientifique, ou positif. En d'autres termes, l'esprit hu	The progress of our conceptions, and of each branch of knowledge, is from beginning to end intrinsically alike. There are not three methods of philosophizing radically opposed; but one method of philosophizing which remains, in essence, the same. At first, and to the last, the conceived causal agencies of phenomena, have a degree of generality corresponding

main, par sa nature, emploie successivement dans chacune de ses recherches trois méthodes de philosopher, dont le caractère est essentiellement différent même radicalement opposé: d'abord la méthode théologique, ensuite la méthode métaphysique, et enfin la méthode positive." *Cours de Philosophie Positive*, 1830, Vol. i. p. 8.

to the width of the generalizations which experiences have determined; and they change just as gradually as experiences accumulate. The integration of causal agencies, originally thought of as multitudinous and local, but finally believed to be one and universal, is a process which involves the passing through all intermediate steps between these extremes; and any appearance of stages can be but superficial. Supposed concrete and individual causal agencies, coalesce in the mind as fast as groups of phenomena are assimilated, or seen to be similarly caused. Along with their coalescence, comes a greater extension of their individualities, and a concomitant loss of distinctness in their individualities. Gradually, by continuance of such coalescences, causal agencies become, in thought, diffused and indefinite. And eventually, without any change in the nature of the process, there is reached the consciousness of a universal causal agency, which cannot be conceived.*

"Le système théologique est parvenu à la plus haute perfection dont il soit susceptible, quand il a substitué l'action providentielle d'un être unique au jeu varié des nombreuses divinités indépendantes qui avaient été imaginées primitivement. De même, le dernier terme du système metaphysique

As the progress of thought is one, so is the end one. There are not three possible terminal conceptions; but only a single terminal conception. When the theological idea of the providential action of one being, is developed to its ultimate form, by the absorption of all independent secondary agencies, it becomes the conception of a being immanent in all phenomena; and the reduction of it to this

* A clear illustration of this process, is furnished by the recent mental integration of Heat, Light, Electricity, etc., as modes of molecular motion. If we go a step back, we see that the modern conception of Electricity, resulted from the integration in consciousness, of the two forms of it involved in the galvanic battery and in the electric-machine. And going back to a still earlier stage, we see how the conception of statical electricity, arose by the coalescence in thought, of the previously-separate forces manifested in rubbed amber, in rubbed glass, and in lightning. With such illustrations before him, no one can, I think, doubt that the process has been the same from the beginning.

consiste à concevoir, au lieu des différentes entités particulières, une seule grande entité générale, la *nature*, envisagée comme la source unique de tous les phénomènes. Pareillement, la perfection du système positif, vers laquelle il tend sans cesse, quoiqu'il soit très-probable qu'il ne doive jamais l'atteindre, serait de pouvoir se représenter tous les divers phénomènes observables comme des cas particuliers d'un seul fait général, tel que celui de la gravitation, par exemple." p. 5.

state, implies the fading-away, in thought, of all those anthropomorphic attributes by which the aboriginal idea was distinguished. The alleged last term of the metaphysical system—the conception of a single great general entity, *nature*, as the source of all phenomena—is a conception identical with the previous one: the consciousness of a single source which, in coming to be regarded as universal, ceases to be regarded as conceivable, differs in nothing but name from the consciousness of one being, manifested in all phenomena. And similarly, that which is described as the ideal state of science—the power to represent all observable phenomena as particular cases of a single general fact, implies the postulating of some ultimate existence of which this single fact is alleged; and the postulating of this ultimate existence, involves a state of consciousness indistinguishable from the other two.

"... la perfection du système positif, vers laquelle il tend sans cesse, quoiqu'il soit très-probable, qu'il ne doive jamais l'atteindre, serait de pouvoir se représenter tous les divers phénomènes observables comme des cas particuliers d'un seul fait général. p. 5. . . . . considérant comme absolument inaccessible, et vide de sens pour nous la recherche de ce qu'on appelle les *causes*, soit premières, soit finales.' p. 14.

Though along with the extension of generalisations, and concomitant integration of conceived causal agencies, the conceptions of causal agencies grow more indefinite; and though as they gradually coalesce into a universal causal agency, they cease to be representable in thought, and are no longer supposed to be comprehensible; yet the consciousness of *cause* remains as dominant to the last as it was at first; and can never be got rid of. The consciousness of cause can be abolished only by abolishing consciousness itself.* (*First Principles*, § 26.)

* Possibly it will be said that M. Comte himself admits that what he calls the perfection of the positive system, will probably never be reached; and that what he condemns is the inquiry into the *natures* of causes and not the general recognition of cause. To the first of these allegations I reply that, as I understand M. Comte, the obstacle to the perfect realization of the positive philosophy is the impossibility of carrying generalization so far as to reduce all particular facts to cases of one general fact—not the impossibility of

"Ce n'est pas aux lecteurs de cet ouvrage que je croirai jamais devoir prouver que les idées gouvernent et bouleversent le monde, ou, en d'autres termes, que tout le mécanisme social repose finalement sur des opinions. Ils savent surtout que la grande crise politique et morale des sociétés actuelles tient, en dernière analyse, à l'anarchie intellectuelle." p. 48.*

Ideas do not govern and overthrow the world: the world is governed or overthrown by feelings, to which ideas serve only as guides. The social mechanism does not rest finally on opinions; but almost wholly on character. Not intellectual anarchy, but moral antagonism, is the cause of political crises. All social phenomena are produced by the totality of human emotions and beliefs; of which the emotions are mainly pre-determined, while the beliefs are mainly post-determined. Men's desires are chiefly inherited; but their beliefs are chiefly acquired, and depend on surrounding conditions; and the most important surrounding conditions depend on the social state which the prevalent desires have produced. The social state at any time existing, is the resultant of all the ambitions, self-interests, fears, reverences, indignations, sympathies, etc., of ancestral citizens and existing citizens. The ideas current in this social state, must, on the average, be congruous with the feelings of citizens; and therefore, on the average, with the social state these feelings have produced. Ideas wholly foreign to this social state excluding the consciousness of cause. And to the second allegation I reply that the essential principle of his philosophy is an avowed ignoring of cause altogether. For if it is not, *what becomes of his alleged distinction between the perfection of the positive system and the perfection of the metaphysical system?* And here let me point out that, by affirming exactly the opposite to that which M. Comte thus affirms, I am excluded from the positive school. If his own definition of positivism is to be taken, then, as I hold that what he defines as positivism is an absolute impossibility, it is clear that I cannot be what he calls a positivist.

* A friendly critic alleges that M. Comte is not fairly represented by this quotation, and that he is blamed by his biographer, M. Littré, for his too-great insistance on feeling as a motor of humanity. If in his "Positive Politics," which I presume is here referred to, M. Comte abandons his original position, so much the better. But I am here dealing with what is known as "the Positive Philosophy;" and that the passage above quoted does not misrepresent it, is proved by the fact that this doctrine is re-asserted at the commencement of the Sociology.

cannot be evolved, and if introduced from without, cannot get accepted—or, if accepted, die out when the temporary phase of feeling which caused their acceptance, ends. Hence, though advanced ideas when once established, act on society and aid its further advance; yet the establishment of such ideas depends on the fitness of the society for receiving them. Practically, the popular character and the social state, determine what ideas shall be current; instead of the current ideas determining the social state and the character. The modification of men's moral natures, caused by the continuous discipline of social life, which adapts them more and more to social relations, is therefore the chief proximate cause of social progress. (*Social Statics*, chap. xxx.)

"... je ne dois pas négliger d'indiquer d'avance, comme une propriété essentielle de l'échelle encyclopédique que je vais proposer, sa conformité générale avec l'ensemble de l'histoire scientifique; en ce sens, que, malgré la simultanéité réelle et continue du développement des différentes sciences, celles qui seront classées comme antérieures seront, en effet, plus anciennes et constamment plus avancées que celles présentées comme postérieures." p. 84. . . . . "Cet ordre est déterminé par le degré de simplicité, ou, ce qui revient au même, par le degré de généralité des phénomènes." p. 87.

The order in which the generalizations of science are established, is determined by the frequency and impressiveness with which different classes of relations are repeated in conscious experience; and this depends, partly on *the directness with which personal welfare is affected*; partly on *the conspicuousness of one or both the phenomena between which a relation is to be perceived*; partly on *the absolute frequency with which the relations occur*; partly on their *relative frequency of occurrence*; partly on their *degree of simplicity*; and partly on their *degree of abstractness*. (*First Principles*, 1st ed., § 86; or otherwise see "*Essay on Laws in General and the Order of their Discovery*.")

"En résultat définitif, la mathématique, l'astronomie, la physique, la chimie, la physiologie, et la physique sociale;

The sciences as arranged in this succession specified by M. Comte, *do not* logically conform to the natural and invariable hierarchy of phenomena; and

telle est la formule encyclopédique qui, parmi le très-grand nombre de classifications que comportent les six sciences fondamentales, est seule logiquement conforme à la hiérarchie naturelle et invariable des phénomènes."* p. 115.

there is no serial order whatever in which they can be placed, which represents either their logical dependence or the dependence of phenomena. (See *Genesis of Science*, and foregoing Essay.)

"On conçoit, en effet, que l'étude rationelle de chaque science fondamentale exigeant la culture préalable de toutes celles qui la précèdent dans notre hiérarchie encyclopédique, n'a pu faire de progrès réels et prendre son véritable caractère, qu' après un grand développement des sciences antérieures relatives à des phénomènes plus généraux, plus abstraits, moins compliqués, et indépendans des autres. C'est donc dans cet ordre que la progression, quoique simultanée, a dû avoir lieu." p. 100.

The historical development of the sciences *has not* taken place in this serial order; nor in any other serial order. There is no "true *filiation* of the sciences." From the beginning, the abstract sciences, the abstract-concrete sciences, and the concrete sciences, have progressed together: the first solving problems which the second and third presented, and growing only by the solution of the problems; and the second similarly growing by joining the first in solving the problems of the third. All along there has been a continuous action and reaction between the three great classes of sciences—an advance from concrete facts to abstract facts, and then an application of such abstract facts to the analysis of new orders of concrete facts. (See *Genesis of Science.*)

Such then are the organizing principles of M. Comte's philosophy and my reasons for rejecting them. Leaving out of his "*Exposition*" those pre-established general

* In 1885, during a controversy with one of M. Comte's English disciples, I was blamed for speaking "of Comte as making six sciences," and was told that "in all Comte's works, except the first, he makes seven sciences." As I was dealing with The Positive Philosophy, I thought I could not do better than give the foregoing extract from the *Cours de Philosophie Positive;* and it did not occur to me that I was called upon to see whether, in any of his later voluminous works, M. Comte had made a different statement. My opponent, however, enlarged on this "blunder," as he politely called it: apparently oblivious of the fact that if it was a blunder on my part to speak of Comte as recognising six sciences when in his later days he recognised seven, it was a much more serious blunder on the part of Comte himself to have long overlooked the seventh.

doctrines which are the common property of modern thinkers; these are the general doctrines which remain—these are the doctrines which fundamentally distinguish his system. From every one of them I dissent. To each proposition I oppose either a widely-different proposition, or a direct negation; and I not only do it now, but have done it from the time when I became acquainted with his writings. The rejection of his cardinal principles should, I think, alone suffice; but there are sundry other views of his, some of them largely characterizing his system, which I equally reject. Let us glance at them.

How organic beings have originated, is an inquiry which M Comte deprecates as a useless speculation: asserting, as he does, that species are immutable.

This inquiry, I believe, admits of answer, and will be answered. That division of Biology which concerns itself with the origin of species, I hold to be the supreme division, to which all others are subsidiary. For on the verdict of Biology on this matter, must wholly depend our conception of human nature, past, present, and future; our theory of the mind; and our theory of society.

M. Comte contends that of what is commonly known as mental science, all that most important part which consists of the subjective analysis of our ideas, is an impossibility.

I have very emphatically expressed my belief in a subjective science of the mind, by writing a *Principles of Psychology*, one half of which is subjective.

M. Comte's ideal of society is one in which *government* is developed to the greatest extent—in which class-functions are far more under conscious public regulation than now—in which hierarchical organization with unquestioned authority shall guide everything — in which the individual life shall be subordinated in the greatest degree to the social life.

That form of society towards which we are progressing, I hold to be one in which *government* will be reduced to the smallest amount possible, and *freedom* increased to the greatest amount possible—one in which human nature will have become so moulded by social discipline into fitness for the social state, that it will need little external restraint, but will be self-restrained —one in which the citizen will tolerate no interference with his freedom, save that which maintains the equal freedom of others—one in which the spontaneous

co-operation which has developed our industrial system, and is now developing it with increasing rapidity, will produce agencies for the discharge of nearly all social functions, and will leave to the primary governmental agency nothing beyond the function of maintaining those conditions to free action, which make such spontaneous co-operation possible—one in which individual life will thus be pushed to the greatest extent consistent with social life; and in which social life will have no other end than to maintain the completest sphere for individual life.

M. Comte, not including in his philosophy the consciousness of a cause manifested to us in all phenomena, and yet holding that there must be a religion, which must have an object, takes for his object—Humanity. "This Collective Life (of Society) is in Comte's system the *Être Suprême*; the only one we can *know* therefore the only one we can worship."

I conceive, on the other hand, that the object of religious sentiment will ever continue to be, that which it has ever been—the unknown source of things. While the *forms* under which men are conscious of the unknown source of things, may fade away, the *substance* of the consciousness is permanent. Beginning with causal agents conceived as imperfectly known; progressing to causal agents conceived as less known and less knowable; and coming at last to a universal causal agent posited as not to be known at all; the religious sentiment must ever continue to occupy itself with this universal causal agent. Having in the course of evolution come to have for its object of contemplation the Infinite Unknowable, the religious sentiment can never again (unless by retrogression) take a Finite Knowable, like Humanity, for its object of contemplation.

Here then, are sundry other points, all of them important, and the last two supremely important, on which I am diametrically opposed to M. Comte; and did space permit, I could add many others. Radically differing from him as I thus do, in everything distinctive of his philosophy; and having invariably expressed my dissent,

publicly and privately, from the time I became acquainted with his writings; it may be imagined that I have been not a little startled to find myself classed as one of the same school. That any who are acquainted with my writings, should suppose I have any general sympathy with M. Comte, save that implied by preferring proved facts to superstitions, astonishes me.

It is true that, disagreeing with M. Comte, though I do, in all those fundamental views that are peculiar to him, I agree with him in sundry minor views. The doctrine that the education of the individual should accord in mode and arrangement with the education of mankind, considered historically, I have cited from him; and have endeavoured to enforce it. I entirely concur in his opinion that there requires a new order of scientific men, whose function shall be that of co-ordinating the results arrived at by the rest. To him, I believe, I am indebted for the conception of a social *consensus*; and when the time comes for dealing with this conception, I shall state my indebtedness. And I also adopt his word, Sociology. There are, I believe, in the part of his writings which I have read, various incidental thoughts of great depth and value; and I doubt not that were I to read more of his writings, I should find others.* It is very probable, too, that I have said (as I am told I have) some things which M. Comte had already said. It would be difficult, I believe, to find two men who had no opinions in common. And it would be extremely strange if two men, starting from the same general doctrines established by modern science, should traverse some of the same fields of inquiry, without their lines of thought having any points of intersection. But

* M. Comte's "Exposition" I read in the original in 1852; and in two or three other places have referred to the original to get his exact words. The Inorganic Physics, and the first chapter of the Biology, I read in Miss Martineau's condensed translation, when it appeared. The rest of M. Comte's views I know only through Mr. Lewes's outline, and through incidental references.

none of these minor agreements can be of much weight in comparison with the fundamental disagreements above specified. Leaving out of view that general community which we both have with the scientific thought of the age, the differences between us are essential, while the correspondences are non-essential. And I venture to think that kinship must be determined by essentials, and not by non-essentials.*

Joined with the ambiguous use of the phrase "Positive Philosophy," which has led to a classing with M. Comte of many men who either ignore or reject his distinctive principles, there has been one special circumstance that has tended to originate and maintain this classing in my own case. The assumption of some relationship between M. Comte and myself, was unavoidably raised by the title of my first book—*Social Statics*. When that book was published, I was unaware that this title had been before used: had I known the fact, I should certainly have adopted an alternative title which I had in view.† If, however, instead of

* In his work, *Auguste Comte et la Philosophie Positive* (1863), M. Littré defending the Comtean classification of the sciences from the criticism I made upon it in the "Genesis of Science," deals with me wholly as an antagonist. The chapter he devotes to his reply, opens by placing me in direct opposition to the English adherents of Comte, named in the preceding chapter.

† I believed at the time, and have never doubted until now, that the choice of this title was absolutely independent of its previous use by M. Comte. While writing these pages, I have found reason to think the contrary. On referring to *Social Statics*, to see what were my views of social evolution in 1850, when M. Comte was to me but a name, I met with the following sentence:—"Social philosophy may be aptly divided (as political economy has been) into statics and dynamics" (ch. xxx. § 1). This I remembered to be a reference to a division which I had seen in the Political Economy of Mr. Mill. But why had I not mentioned Mr. Mill's name? On referring to the first edition of his work, I found, at the opening of Book iv., this sentence:—"The three preceding parts include as detailed a view as the limits of this treatise permit, of what, by a happy generalization of a mathematical phrase, has been called the Statics of the subject." Here was the solution of the question. The division had not been made by Mr. Mill, but by some writer (on Political Economy I supposed) who was not named by him; and whom I did not

the title, the work itself be considered, its irrelation to the philosophy of M. Comte becomes abundantly manifest. There is decisive testimony on this point. In the *North British Review* for August, 1851, a reviewer of *Social Statics* says—

"The title of this work, however, is a complete misnomer. According to all analogy, the phrase "Social Statics" should be used only in some such sense as that in which, as we have already explained, it is used by Comte, namely as designating a branch of inquiry whose end it is to ascertain the laws of social equilibrium or order, as distinct ideally from those of social movement or progress. Of this Mr. Spencer does not seem to have had the slightest notion, but to have chosen the name for his work only as a means of indicating vaguely that it proposed to treat of social concerns in a scientific manner."—p. 321.

Respecting M. Comte's application of the words *statics* and *dynamics* to social phenomena, now that I know what it is, I will only say that while I perfectly understand how, by a defensible extension of their mathematical meanings, the one may be used to indicate social *functions in balance*, and the other social *functions out of balance*, I am quite at a loss to understand how the phenomena of *structure* can be included in the one any more than in the other. But the two things which here concern me, are, first, to point out that I had not "the slightest notion" of giving Social Statics the meaning which M. Comte gave it; and, second, to explain the meaning which I did give it. The units of any aggregate of matter, are in equilibrium when they severally act and re-act on one another on all sides with equal forces. A state of change among them implies that there are forces exercised by some that are not counterbalanced by like forces exercised by others; and a state of rest implies the absence of such uncounterbalanced forces—

know. It is now manifest, however, that while I supposed I was giving a more extended use to this division, I was but returning to the original use which Mr. Mill had limited to his special topic. Another thing is, I think, tolerably manifest. As I evidently wished to point out my obligation to some unknown political economist, whose division I thought I was extending, I should have named him had I known who he was. And in that case should not have put this extension of the division as though it were new

implies, if the units are homogeneous, equal distances among them—implies a maintenance of their respective spheres of molecular motion. Similarly among the units of a society, the fundamental condition to equilibrium, is, that the restraining forces which the units exercise on each other, shall be balanced. If the spheres of action of some units are diminished by extension of the spheres of action of others, there necessarily results an unbalanced force which tends to produce political change in the relations of individuals; and the tendency to change can cease, only when individuals cease to aggress on each other's spheres of action—only when there is maintained that law of equal freedom, which it was the purpose of *Social Statics* to enforce in all its consequences. Besides this totally-unlike conception of what constitutes Social Statics, the work to which I applied that title, is fundamentally at variance with M. Comte's teachings in almost everything. So far from alleging, as M. Comte does, that society is to be re-organized by philosophy; it alleges that society is to be re-organized only by the accumulated effects of habit on character. Its aim is not the increase of authoritative control over citizens, but the decrease of it. A more pronounced individualism, instead of a more pronounced nationalism, is its ideal. So profoundly is my political creed at variance with the creed of M. Comte, that, unless I am misinformed, it has been instanced by a leading English disciple of M. Comte as the creed to which he has the greatest aversion. One point of coincidence, however, is recognizable. The analogy between an individual organism and a social organism, which was held by Plato and by Hobbes, is asserted in *Social Statics*, as it is in the *Sociology* of M. Comte. Very rightly, M. Comte has made this analogy the cardinal idea of this division of his philosophy. In *Social Statics*, the aim of which is essentially ethical, this analogy is pointed out incidentally, to enforce certain ethical considerations; and is there obviously suggested partly by the definition of life which

Coleridge derived from Schelling, and partly by the generalizations of physiologists there referred to (chap. xxx. §§. 12, 13, 16). Excepting this incidental agreement, however, the contents of *Social Statics* are so entirely antagonistic to the philosophy of M. Comte, that, but for the title, the work would never, I think, have raised the remembrance of him—unless, indeed, by the association of opposites.*

And now let me point out that which really *has* exercised a profound influence over my course of thought. The truth which Harvey's embryological inquiries first dimly indicated, which was afterwards more clearly perceived by Wolff, and which was put into a definite shape by Von Baer—the truth that all organic development is a change from a state of homogeneity to a state of heterogeneity—this it is from which very many of the conclusions which I now hold, have indirectly resulted. In *Social Statics*, there is everywhere manifested a dominant belief in the evolution of man and of society. There is also manifested the belief that this evolution is in both cases determined by the incidence of conditions—the actions of circumstances. And there is further, in the sections already referred to, a recognition of the fact that organic and social evolutions, conform to the same law. Falling amid beliefs in evolutions of various orders, everywhere determined by natural causes (beliefs

* Let me add that the conception developed in *Social Statics*, dates back to a series of letters on the "Proper Sphere of Government," published in the *Nonconformist* newspaper in the latter half of 1842, and republished as a pamphlet in 1843. In these letters will be found, along with many crude ideas, the same belief in the conformity of social phenomena to unvariable laws; the same belief in human progression as determined by such laws; the same belief in the moral modification of men as caused by social discipline; the same belief in the tendency of social arrangements "of themselves to assume a condition of *stable* equilibrium;" the same repudiation of state-control over various departments of social life; the same limitation of state-action to the maintenance of equitable relations among citizens. The writing of *Social Statics* arose from a dissatisfaction with the basis on which the doctrines set forth in those letters were placed: the second half of that work is an elaboration of these doctrines; and the first half a statement of the principles from which they are deducible.

again displayed in the *Theory of Population* and in the *Principles of Psychology*); the formula of Von Baer set up a process of organization. The extension of it to other kinds of phenomena than those of individual and social bodies, is traceable through successive stages. It may be seen in the last paragraph of an essay on "The Philosophy of Style," published in October, 1852; again in an essay on "Manners and Fashion," published in April, 1854; and then, in a comparatively advanced form, in an essay on "Progress: its Law and Cause," published in April, 1857. Afterwards, there came the recognition of the need for modifying Von Baer's formula by including the trait of increasing definiteness; next the inquiry into those general laws of force from which this universal transformation necessarily results; next the deduction of these from the ultimate law of the persistence of force; next the perception that there is everywhere a process of Dissolution complementary to that of Evolution; and, finally, the determination of the conditions (specified in the foregoing essay) under which Evolution and Dissolution respectively occur. The filiation of these results is, I think, tolerably manifest. The process has been one of continuous development, set up by the addition of Von Baer's law to a number of ideas that were in harmony with it. And I am not conscious of any other influences by which the process has been affected.

It is possible, however, that there may have been influences of which I am not conscious; and my opposition to M. Comte's system may have been one of them. The presentation of antagonistic thoughts, often produces greater definiteness and development of one's own thoughts. It is probable that the doctrines set forth in the essay on "The Genesis of Science," might never have been reached, had not my dissent from M. Comte's conception, led me to work them out; and but for this, I might not have arrived at the classification of the sciences exhibited in the foregoing essay. Possibly there are other cases in which the stimulus of

repugnance to M. Comte's views, may have aided in elaborating my own views; though I cannot call to mind any other cases.

Let it by no means be supposed from all I have said, that I do not regard M. Comte's speculations as of value. True or untrue, his system as a whole, has doubtless produced important and salutary revolutions of thought in many minds; and will doubtless do so in many more. Doubtless, too, not a few of those who dissent from his general views, have been healthfully stimulated by consideration of them. The presentation of scientific knowledge and method as a whole, whether rightly or wrongly co-ordinated, cannot have failed greatly to widen the conceptions of most of his readers. And he has done especial service by familiarizing men with the idea of a social science, based on the other sciences. Beyond which benefits resulting from the general character and scope of his philosophy, I believe that there are scattered through his pages many large ideas that are valuable not only as stimuli, but for their actual truth.

It has been by no means an agreeable task to make these personal explanations; but it has seemed to me a task not to be avoided. Differing so profoundly as I do from M. Comte on all fundamental doctrines, save those which we inherit in common from the past; it has become needful to dissipate the impression that I agree with him—needful to show that a large part of what is currently known as "positive philosophy," is not "positive philosophy" in the sense of being peculiarly M. Comte's philosophy; and to show that beyond that portion of the so-called "positive philosophy" which is not peculiar to him, I dissent from it.

And now at the close, as at the outset, let me express my great regret that these explanations should have been called forth by the statements of a critic who has treated me so liberally. Nothing will, I fear, prevent the foregoing pages from appearing like a very ungracious response to M. Laugel's sympathetically-written review. I can only hope that the gravity of the question at issue, in so far as it

concerns myself, may be taken in mitigation, if not as a sufficient apology.

NOTE.

The preceding pages originally formed the second portion of a pamphlet entitled The Classification of the Sciences: to which are added Reasons for dissenting from the Philosophy of M. Comte, *which was first published in* 1864. *For some time past this pamphlet has been included in the third volume of my* Essays, &c., *and has been no longer accessible in a separate form. There has recently been diffused afresh, the misconception which originally led me to exhibit my entire rejection of those views of M. Comte, which essentially distinguish his system from other systems; and the motives which then prompted me to publish the reasons for this rejection, now prompt me to put them within the reach of all who care to inquire about the matter. The Appendix, presenting an outline of the leading propositions of the Synthetic Philosophy, will further aid the reader in forming a correct judgment.*

Oct. 7, 1884.

APPENDIX A.

Some fourteen or more years ago, an American friend requested me, with a view to a certain use which he named, to furnish him with a succinct statement of the cardinal principles developed in the successive works I had published and in those I was intending to publish. This statement I here reproduce. Having been written solely for an expository purpose, and without thought of M. Comte and his system, it will serve better than a statement now drawn up since it is not open to the suspicion of being adapted to the occasion.*

"1. Throughout the universe in general and in detail, there is an unceasing redistribution of matter and motion.

"2. This redistribution constitutes evolution where there is a pre-

* Published many years since in America, this statement was republished in England eight years since. See *Athenæum* for July 22nd, 1882.

dominant integration of matter and dissipation of motion, and constitutes dissolution where there is a predominant absorption of motion and disintegration of matter.

"8. Evolution is simple when the process of integration, or the formation of a coherent aggregate, proceeds uncomplicated by other processes.

"4 Evolution is compound when, along with this primary change from an incoherent to a coherent state, there go on secondary changes due to differences in the circumstances of the different parts of the aggregate.

"5. These secondary changes constitute a transformation of the homogeneous into the heterogeneous—a transformation which, like the first, is exhibited in the universe as a whole and in all (or nearly all) its details: in the aggregate of stars and nebulæ; in the planetary system; in the earth as an inorganic mass; in each organism, vegetal or animal (Von Baer's law); in the aggregate of organisms throughout geologic time; in the mind; in society; in all products of social activity.

"6. The process of integration, acting locally as well as generally, combines with the process of differentiation to render this change not simply from homogeneity to heterogeneity, but from an indefinite homogeneity to a definite heterogeneity; and this trait of increasing definiteness, which accompanies the trait of increasing heterogeneity, is, like it, exhibited in the totality of things and in all its divisions and sub-divisions down to the minutest.

"7. Along with this redistribution of the matter composing any evolving aggregate, there goes on a redistribution of the retained motion of its components in relation to one another: this also becomes, step by step, more definitely heterogeneous.

"8. In the absence of a homogeneity that is infinite and absolute, that redistribution of which evolution is one phase, is inevitable. The causes which necessitate it are these:—

"9. The instability of the homogeneous, which is consequent upon the different exposures of the different parts of any limited aggregate to incident forces. The transformations hence resulting are complicated by—

"10. The multiplication of effects. Every mass and part of a mass on which a force falls, sub-divides and differentiates that force, which thereupon proceeds to work a variety of changes; and each of these becomes the parent of similarly-multiplying changes: the multiplication of them becoming greater in proportion as the aggregate becomes more heterogeneous. And these two causes of increasing differentiations are furthered by—

"11. Segregation, which is a process tending ever to separate unlike units and to bring together like units—so serving continually to sharpen, or make definite, differentiations otherwise caused.

"12. Equilibration is the final result of these transformations which an evolving aggregate undergoes. The changes go on until there is reached an equilibrium between the forces which all parts of the aggregate are exposed to and the forces these parts oppose to them. Equilibration may pass through a transition stage of balanced motions (as in a planetary system) or of

balanced functions (as in a living body) on the way to ultimate equilibrium; but the state of rest in inorganic bodies, or death in organic bodies, is the necessary limit of the changes constituting evolution.

"13. Dissolution is the counter-change which sooner or later every evolved aggregate undergoes. Remaining exposed to surrounding forces that are unequilibrated, each aggregate is ever liable to be dissipated by the increase, gradual or sudden, of its contained motion; and its dissipation, quickly undergone by bodies lately animate and slowly undergone by inanimate masses, remains to be undergone at an indefinitely remote period by each planetary and stellar mass, which, since an indefinitely distant period in the past, has been slowly evolving: the cycle of its transformations being thus completed.

"14. This rhythm of evolution and dissolution, completing itself during short periods in small aggregates, and in the vast aggregates distributed through space completing itself in periods which are immeasurable by human thought, is, so far as we can see, universal and eternal—each alternating phase of the process predominating now in this region of space and now in that, as local conditions determine.

"15. All these phenomena, from their great features down to their minutest details, are necessary results of the persistence of force, under its forms of matter and motion. Given these as distributed through space, and their quantities being unchangeable, either by increase or decrease, there inevitably result the continuous redistributions distinguishable as evolution and dissolution, as well as all those special traits above enumerated.

"16. That which persists unchanging in quantity but ever changing in form, under these sensible appearances which the universe presents to us, transcends human knowledge and conception—is an unknown and unknowable power, which we are obliged to recognize as without limit in space and without beginning or end in time."

These successive paragraphs set forth in the most abstract way, that process of transformation going on throughout the Cosmos as a whole, and in each larger or smaller portion of it. In *First Principles* the statements contained in these paragraphs are elaborated, explained, and illustrated; and in subsequent volumes of the series, the purpose has been to interpret the several great groups of phenomena, Astronomical, Geological (both postponed), Biological, Psychological, Sociological, and Ethical, in conformity with these general laws of Evolution which *First Principles* enunciates.

If it can be shown that any one of the above propositions has been adopted from, or has been suggested by, the

Positive Philosophy, there will be evidence that the Synthetic Philosophy is to that extent indebted to it. Or if there can be quoted any expressed conviction of M. Comte, that the factors producing changes of all kinds, inorganic and organic, co-operate everywhere throughout the Cosmos in the same general way, and everywhere work metamorphoses having the same essential traits, a much more decided indebtedness may reasonably be supposed.

So far as I know it, however, the Positive Philosophy contains none of the special ideas above enumerated, nor any of the more general ideas they involve.

APPENDIX B.

On pp. 119 and 120, I have pointed out that the followers of M. Comte, swayed by the spirit of discipleship, habitually ascribe to him a great deal which was the common inheritance of the scientific world before he wrote, and to which he himself laid no claim. Kindred remarks have since been made by others, both in England and in France —the one by Mr. Mill, and the other by M. Fouillée. Mr. Mill says :—

"The foundation of M. Comte's philosophy is thus in no way peculiar to him, but the general property of the age, however far as yet from being universally accepted even by thoughtful minds. The philosophy called Positive is not a recent invention of M. Comte, but a simple adherence to the traditions of all the great scientific minds whose discoveries have made the human race what it is. M. Comte has never presented it in any other light. But he has made the doctrine his own by his manner of treating it." —*Auguste Comte and Positivism*, pp. 8, 9.

In his *Histoire de la Philosophie*, 1875, M. Alfred Fouillée writes :—

"Saint-Simon voulut successivement organiser la société à l'aide de la science (prétention d'où sortit le positivisme) puis à l'aide de l'industrie, et enfin à l'aide d'une religion nouvelle, capable de 'forcer chacun de ses membres à suivre le précepte de l'amour du prochain.'"—p. 428.

"Les doctrines sociales de Saint-Simon, jointes au naturalisme de Cabanis et de Broussais, donnèrent naissance au 'positivisme' d'Auguste Comte

Ce dernier, comme Saint-Simon, voit dans la science sociale ou 'sociologie' le terme et le but de toutes les recherches scientifiques."—p. 422.

"A cette méthode Auguste Comte ajouta des vues historiques, qu'il croyait entièrement originales, sur les trois états par où passe nécessairement selon lui la connaissance humaine: état théologique, état métaphysique, et état scientifique. Le germe de cette théorie était déjà dans Turgot."—p. 424.

"En somme, Auguste Comte a eu le mérite d'insister sur les méthodes qui conviennent aux sciences de la nature; mais il faut avouer que ces méthodes étaient connues bien avant lui."—p. 425.

ON LAWS IN GENERAL, AND THE ORDER OF THEIR DISCOVERY.

[*The following was contained in the first edition of* First Principles. *I omitted it from the re-organised second edition, because it did not form an essential part of the new structure. As it is referred to in the foregoing pages, and as its general argument is germane to the contents of those pages, I have thought well to insert it here. Moreover, though I hope eventually to incorporate it in that division of the* Principles of Sociology *which treats of Intellectual Progress, yet as it must be long before it can thus re-appear in its permanent place, and as, should I not get so far in the execution of my undertaking, it may never thus re-appear at all, it seems proper to make it more accessible than it is at present. The first and last sections, which served to link it into the argument of the work to which it originally belonged, are omitted. The rest has been carefully revised, and in some parts considerably altered.*]

The recognition of Law being the recognition of uniformity of relations among phenomena, it follows that the order in which different groups of phenomena are reduced to law, must depend on the frequency with which the uniform relations they severally display are distinctly experienced. At any given stage of progress, those uni-

formities will be best known with which men's minds have been oftenest and most strongly impressed. In proportion partly to the number of times a relation has been presented to consciousness (not merely to the senses), and in proportion partly to the vividness with which the terms of the relation have been cognized, will be the degree in which the constancy of connexion is perceived.

The succession in which relations are generalized being thus determined, there result certain derivative principles to which this succession must more immediately and obviously conform. The first is *the directness with which personal welfare is affected.* While, among surrounding things, many do not appreciably influence us in any way, some produce pleasures and some pains, in various degrees; and manifestly, those things of which the actions on the organism for good or evil are most decided, will, *cæteris paribus*, be those of which the laws of action are earliest observed. Second comes *the conspicuousness of one or both phenomena between which a relation is to be perceived.* On every side are phenomena so concealed as to be detected only by close observation; others not obtrusive enough to attract notice; others which moderately solicit the attention; others so imposing or vivid as to force themselves on consciousness; and, supposing conditions to be the same, these last will of course be among the first to have their relations generalized. In the third place, we have *the absolute frequency with which the relations occur.* There are coexistences and sequences of all degrees of commonness, from those which are ever present to those which are extremely rare; and manifestly, the rare coexistences and sequences, as well as the sequences which are very long in taking place, will not be reduced to law so soon as those which are familiar and rapid. Fourthly has to be added *the relative frequency of occurrence.* Many events and appearances are limited to certain times or certain places, or both;

and, as a relation which does not exist within the environment of an observer cannot be perceived by him, however common it may be elsewhere or in another age, we have to take account of the surrounding physical circumstances, as well as of the state of society, of the arts, and of the sciences—all of which affect the frequency with which certain groups of facts are observable. The fifth corollary to be noticed is, that the succession in which different classes of relations are reduced to law, depends in part on their *simplicity*. Phenomena presenting great composition of causes or conditions, have their essential relations so masked, that it requires accumulated experiences to impress upon consciousness the true connexions of antecedents and consequents they involve. Hence, other things equal, the progress of generalization will be from the simple to the complex; and this it is which M. Comte has wrongly asserted to be the sole regulative principle of the progress. Sixth comes *the degree of concreteness, or absence of abstractness*. Concrete relations are the earliest acquisitions. Such analyses of them as separate the essential connexions from their disguising accompaniments, necessarily come later. The analyses of the connexions, always more or less compound, into their elements then becomes possible. And so on continually, until the highest and most abstract truths have been reached.

These, then, are the several derivative principles. The frequency and vividness with which uniform relations are repeated in conscious experience, determining the recognition of their uniformity, and this frequency and vividness depending on the above conditions, it follows that the order in which different classes of facts are generalized, must depend on the extent to which the above conditions are fulfilled in each class. Let us mark how the facts harmonize with this conclusion: taking first a few that elucidate the general truth, and afterwards some that

exemplify the special truths which we here see follow from it.

The relations earliest known as uniformities, are those subsisting among the common properties of matter—tangibility, visibility, cohesion, weight, etc. We have no trace of a time when the resistance offered by an object was regarded as caused by the will of the object; or when the pressure of a body on the hand holding it, was ascribed to the agency of a living being. And accordingly, these are the relations of which we are oftenest conscious: being, as they are, objectively frequent, conspicuous, simple, concrete, and of immediate personal concern.

Similarly with the ordinary phenomena of motion. The fall of a mass on the withdrawal of its support, is a sequence which directly affects bodily welfare, is conspicuous, simple, concrete, and very often repeated. Hence it is one of the uniformities recognized before the dawn of tradition. We know of no era when ordinary movements due to terrestrial gravitation were attributed to volition. Only when the relation is obscured, as where the withdrawal of a support is not obvious, or, as in the case of an aërolite, where the antecedent of the descent is unperceived, do we find the conception of personal agency. On the other hand, motions of intrinsically the same order as that of a falling stone—those of the heavenly bodies—long remain ungeneralized; and until their uniformity is seen, and indeed for a long time after, are construed as results of will. This difference is clearly not dependent on comparative complexity or abstractness, since the motion of a planet in an ellipse of slight eccentricity, is as simple and concrete a phenomenon as the motion of a projected arrow in an ellipse of extreme eccentricity indistinguishable from a parabola. But the antecedents are not conspicuous; the sequences are of long duration; and they are not often repeated. And that these are the causes of their slow

reduction to law, we see in the fact that they are severally generalized in the order of their frequency and conspicuousness—the moon's monthly cycle, the sun's annual change, the periods of the inferior planets, the periods of the superior planets.

While astronomical sequences were still ascribed to volition, certain terrestrial sequences of a different kind, but some of them equally without complication, were interpreted in like mannêr. The solidification of water at a low temperature, is a phenomenon that is simple, concrete, and of much personal concern. But it is neither so frequent as those which we see are earliest generalized, nor is the presence of the antecedent so manifest. Though in all but tropical climates, mid-winter displays the relation between cold and freezing with tolerable constancy; yet, during the spring and autumn, the occasional appearance of ice in the mornings has no very obvious connexion with coldness of the weather. Sensation being so inaccurate a measure, it is not possible for the savage to experience the definite relation between a temperature of 32° and the congealing of water; and hence the long continued belief in personal agency. Similarly, but still more clearly, with the winds. The absence of regularity and the inconspicuousness of the antecedents, allowed the mythological explanation to survive for a great period.

During the era in which the uniformity of many quite simple inorganic relations was still unrecognized, certain organic relations, intrinsically very complex and special, were generalized. The constant coexistence of feathers and a beak, of four legs with an internal bony framework, are facts which were, and are, familiar to every savage. Did a savage find a bird with teeth, or a mammal clothed with feathers, he would be as much surprised as an instructed naturalist. Now these uniformities of organic structure thus early perceived, are of exactly the same kind as those more numerous ones later established by biology. The constant

coexistence of mammary glands with two occipital condyles to the skull, of vertebræ with teeth lodged in sockets, of frontal horns with the habit of rumination, are generalizations as purely empirical as those known to the aboriginal hunter. The botanist cannot in the least understand the complex relation between papilionaceous flowers and seeds borne in flattened pods: he knows these and like connexions simply in the same way that the barbarian knows the connexions between particular leaves and particular kinds of wood. But the fact that sundry of the uniform relations which chiefly make up the organic sciences, were very early recognized, is due to the high degrees of vividness and frequency with which they were presented to consciousness. Though the connexion between the sounds characteristic of a certain bird, and the possession of edible flesh, is extremely involved, yet the two terms of the relation are conspicuous, often recur in experience, and a knowledge of their connexion has a direct bearing on personal welfare. Meanwhile innumerable relations of the same order, which are displayed with even greater frequency by surrounding plants and animals, remain for thousands of years unrecognized, if they are unobtrusive or of no apparent moment.

When, passing from this primitive stage to a more advanced stage, we trace the discovery of those less familiar uniformities which mainly constitute what is distinguished as Science, we find the succession in which knowledge of them is reached, to be still determined in the same manner. This will become obvious on contemplating separately the influence of each derivative condition.

How relations that have immediate bearings on the maintenance of life, are, other things equal, fixed in the mind before those which have no immediate bearings, the history of Science abundantly illustrates. The habits of existing uncivilized races, who fix times by moons and barter so many of one article for so many of another, show

as that conceptions of equality and number, which are the germs of mathematical science, were developed under the immediate pressure of personal wants; and it can scarcely be doubted that those laws of numerical relations which are embodied in the rules of arithmetic, were first brought to light through the practice of mercantile exchange. Similarly with geometry. The derivation of the word shows us that it originally included only certain methods of partitioning ground and laying out buildings. The properties of the scales and the lever, involving the first principle in mechanics, were early generalized under the stimulus of commercial and architectural needs. To fix the times of religious festivals and agricultural operations, were the motives which led to the establishment of the simpler astronomic periods. Such small knowledge of chemical relations as was involved in ancient metallurgy, was manifestly obtained in seeking how to improve tools and weapons. In the alchemy of later times, we see how greatly an intense hope of private benefit contributed to the disclosure of a certain class of uniformities. Nor is our own age barren of illustrations. "Here," says Humboldt, when in Guiana, "as in many parts in Europe, the sciences are thought worthy to occupy the mind, only so far as they confer some immediate and practical benefit on society." "How is it possible to believe," said a missionary to him, "that you have left your country to come to be devoured by mosquitoes on this river, and to measure lands that are not your own?" Our coasts furnish like instances. Every sea-side naturalist knows how great is the contempt with which fishermen regard the collection of objects for the microscope or aquarium. Their incredulity as to the possible value of such things is so great, that they can scarcely be induced even by bribes to preserve the refuse of their nets. Nay, we need not go for evidence beyond daily table-talk. The demand for "practical science"—for a knowledge that can be brought to bear on the business of

life—joined to the ridicule commonly vented on scientific pursuits having no obvious uses, suffice to show that the order in which laws are discovered greatly depends on the directness with which knowledge of them affects our welfare.

That, when all other conditions are the same, obtrusive relations will be generalized before unobtrusive ones, is so nearly a truism that examples appear almost superfluous. If it be admitted that by the aboriginal man, as by the child, the co-existent properties of large surrounding objects are noticed before those of minute objects, and that the external relations which bodies present are generalized before their internal relations, it must be admitted that in subsequent stages of progress, the comparative conspicuousness of relations has greatly affected the order in which they were recognized as uniform. Hence it happened that after the establishment of those very manifest sequences constituting a lunation, and those less manifest ones marking a year, and those still less manifest ones marking the planetary periods, astronomy occupied itself with such inconspicuous sequences as those displayed in the repeating cycle of lunar eclipses, and those which suggested the theory of epicycles and eccentrics; while modern astronomy deals with still more inconspicuous sequences, some of which, as the planetary rotations, are nevertheless the simplest which the heavens present. In physics, the early use of canoes implied an empirical knowledge of certain hydrostatic relations that are intrinsically more complex than sundry static relations not empirically known; but these hydrostatic relations were thrust upon observation. Or, if we compare the solution of the problem of specific gravity by Archimedes with the discovery of atmospheric pressure by Torricelli (the two involving mechanical relations of the same class), we perceive that the much earlier occurrence of the first than the last was determined, neither by a difference in their bearings on personal welfare, nor by a difference in the frequency with

which illustrations of them came under observation, nor by relative simplicity; but by the greater obtrusiveness of the connexion between antecedent and consequent in the one case than in the other. Among miscellaneous illustrations, it may be pointed out that the connexions between lightning and thunder, and between rain and clouds, were recognized long before others of the same order, simply because they thrust themselves on the attention. Or the long-delayed discovery of the microscopic forms of life, with all the phenomena they present, may be named as very clearly showing how certain groups of relations not ordinarily perceptible, though in other respects like long-familiar relations, have to wait until changed conditions render them perceptible. But, without further details, it needs only to consider the inquiries which now occupy the electrician, the chemist, the physiologist, to see that science has advanced, and is advancing, from the more conspicuous phenomena to the less conspicuous ones.

How the degree of absolute frequency of a relation affects the recognition of its uniformity, we see in contrasting certain biological facts. The connexion between death and bodily injury, constantly displayed not only in men but in all inferior creatures, came to be recognized as an instance of natural causation while yet deaths from diseases or from some of them continued to be thought supernatural. Among diseases themselves, it is observable that unusual ones were regarded as of demoniacal origin during ages when the more frequent were ascribed to ordinary causes: a truth paralleled among our own peasantry, who by the use of charms show a lingering superstition with respect to rare disorders, which they do not show with respect to common ones, such as colds. Passing to physical illustrations, we may note that within the historic period whirlpools were accounted for by the agency of water-spirits; but we do not find that within the same period the disappearance of water on exposure either to the sun or to artificial heat was

interpreted in an analogous way: though a more marvellous occurrence, and a more complex one, its great frequency led to the early recognition of it as a natural uniformity. Rainbows and comets do not differ much in conspicuousness, and a rainbow is intrinsically the more involved phenomenon; but chiefly because of their far greater commonness, rainbows were perceived to have a direct dependence on sun and rain while yet comets were regarded as signs of divine wrath.

That races living inland must long have remained ignorant of the daily and monthly sequences of the tides, and that tropical races could not early have comprehended the phenomena of northern winters, are extreme illustrations of the influence which relative frequency has on the recognition of uniformities. Animals which, where they are indigenous, call forth no surprise by their structures or habits, because these are so familiar, when taken to countries where they have never been seen, are looked at with an astonishment approaching to awe—are even thought supernatural: a fact which will suggest numerous others that show how the localization of phenomena shares in controlling the order in which they are reduced to law. Not only however does their localization in space affect the progression, but also their localization in time. Facts which are rarely if ever manifested in one era, are rendered very frequent in another, simply through the changes wrought by civilization. The lever, of which the properties are illustrated in the use of sticks and weapons, is vaguely understood by every savage—on applying it in a certain way he rightly anticipates certain effects; but the wheel-and-axle, pulley, and screw, cannot have their powers either empirically or rationally known till the advance of the arts has more or less familiarized them. Through those various means of exploration which we have inherited and added to, we have become acquainted with a vast range of chemical relations that were relatively non-

existent to the primitive man. To highly-developed industries we owe both the substances and the appliances that have disclosed to us countless uniformities which our ancestors had no opportunity of seeing. These and like instances, show that the accumulated materials, and processes, and products, which characterize the environments of complex societies, greatly increase the accessibility of various classes of relations; and by thus multiplying the experiences of them, or making them relatively frequent, facilitate the generalization of them. Moreover, various classes of phenomena presented by society itself, as for instance those which political economy formulates, become relatively frequent, and therefore recognizable, in advanced social states; while in less advanced ones they are either too rarely displayed to have their relations perceived, or, as in the least advanced ones, are not displayed at all.

That, where no other circumstances interfere, the order in which different uniformities are established varies as their complexity, is manifest. The geometry of straight lines was understood before the geometry of curved lines; the properties of the circle before the properties of the ellipse, parabola, and hyperbola; and the equations of curves of single curvature were ascertained before those of curves of double curvature. Plane trigonometry comes in order of time and simplicity before spherical trigonometry; and the mensuration of plane surfaces and solids before the mensuration of curved surfaces and solids. Similarly with mechanics: the laws of simple motion were generalized before those of compound motion; and those of rectilinear motion before those of curvilinear motion. The properties of equal-armed levers or scales, were understood before those of levers with unequal arms; and the law of the inclined plane was formulated earlier than that of the screw, which involves it. In chemistry the progress has been from the simple inorganic compounds to the more involved or organic compounds. And where, as in the higher sciences, the conditions of the exploration are

more complicated, we still may trace relative complexity as determining the order of discovery where other things are equal.

The progression from concrete relations to abstract relations, and from the less abstract to the more abstract, is equally obvious. Numeration, which in its primary form concerned itself only with groups of actual objects, came earlier than simple arithmetic; the rules of which deal with numbers apart from objects. Arithmetic, limited in its sphere to concrete numerical relations, is alike earlier and less abstract than Algebra, which deals with the relations of these relations. And in like manner, the Calculus of Operations comes after Algebra, both in order of evolution and in order of abstractness. In Mechanics, the more concrete relations of forces exhibited in the lever, inclined plane, etc., were understood before the more abstract relations expressed in the laws of resolution and composition of forces; and later than the three abstract laws of motion as formulated by Newton came the still more abstract law of inertia. Similarly with Physics and Chemistry, there has been an advance from truths entangled in all the specialities of particular facts and particular classes of facts, to truths disentangled from the disguising incidents under which they are manifested—to truths of a higher abstractness.

Brief and rude as is this sketch of a mental development which has been long and complicated, I venture to think it shows inductively what was deductively inferred, that the order in which separate groups of uniformities are recognized, depends not on one circumstance but on several circumstances. The various classes of relations are generalized in a certain succession, not solely because of one particular kind of difference in their natures; but also because they are variously placed in time and in space, variously open to observation, and variously related to our own constitutions: our perception of them being influenced by all these conditions in endless combinations. The comparative degrees

of importance, of obtrusiveness, of absolute frequency, of relative frequency, of simplicity, of concreteness, are every one of them factors; and from their unions in proportions that are never twice alike, there results a highly complex process of mental evolution. But while it is thus manifest that the proximate causes of the succession in which relations are reduced to law, are numerous and involved; it is also manifest that there is one ultimate cause to which these proximate causes are subordinate. As the several circumstances that determine the early or late recognition of uniformities are circumstances that determine the number and strength of the impressions which these uniformities make on the mind, it follows that the progression conforms to a certain fundamental principle of psychology. We see *a posteriori*, what we concluded *a priori*, that the order in which relations are generalized, depends on the frequency and impressiveness with which they are repeated in conscious experience.

Having roughly analyzed the progress of the past, let us take advantage of the light thus thrown on the present, and consider what is implied respecting the future.

Note, first, that the likelihood of the universality of Law has been ever growing greater. Out of the countless coexistences and sequences with which mankind are environed, they have been continually transferring some from the group whose order was supposed to be arbitrary, to the group whose order is known to be uniform. And manifestly, as fast as the relations which are unreduced to law become fewer, the probability that among them there are some which do not conform to law, becomes less. To put the argument numerically—It is clear that when out of surrounding phenomena a hundred of several kinds have been found to occur in constant connexions, there arises a slight presumption that all phenomena occur in constant connexions. When uniformity has been established in a thousand cases, more varied

in their kinds, the presumption gains strength. And when the known cases of uniformity amount to millions, including many of each variety, it becomes an ordinary induction that uniformity exists everywhere.

Silently and insensibly their experiences have been pressing men on towards the conclusion thus drawn. Not out of a conscious regard for these reasons, but from a habit of thought which these reasons formulate and justify, all minds have been advancing towards a belief in the constancy of surrounding coexistences and sequences. Familiarity with concrete uniformities has generated the abstract conception of uniformity—the idea of *Law;* and this idea has been in successive generations slowly gaining fixity and clearness. Especially has it been thus among those whose knowledge of natural phenomena is the most extensive—men of science. The mathematician, the physicist, the astronomer, the chemist, severally acquainted with the vast accumulations of uniformities established by their predecessors, and themselves daily adding new ones as well as verifying the old, acquire a far stronger faith in law than is ordinarily possessed. With them this faith, ceasing to be merely passive, becomes an active stimulus to inquiry. Wherever there exist phenomena of which the dependence is not yet ascertained, these most cultivated intellects, impelled by the conviction that here too there is some invariable connexion, proceed to observe, compare, and experiment; and when they discover the law to which the phenomena conform, as they eventually do, their general belief in the universality of law is further strengthened. So overwhelming is the evidence, and such the effect of this discipline, that to the advanced student of Nature, the proposition that there are lawless phenomena has become not only incredible but almost inconceivable.

This habitual recognition of law which already distinguishes modern thought from ancient thought, must spread among men at large. The fulfilment of fresh predictions that are made possible by every new step, and the further

command gained over Nature's forces, prove to the uninitiated the validity of scientific generalizations and the doctrine they illustrate. Widening education is daily diffusing among the mass of men that knowledge of these generalizations which has been hitherto confined to the the few. And as fast as this diffusion goes on, the belief of the scientific must become the belief of the world at large.

That law is universal, will become an irresistible conclusion when it is perceived that *the progress in the discovery of laws itself conforms to law;* and when this perception makes it clear why certain groups of phenomena have been reduced to law, while other groups are still unreduced. When it is seen that the order in which uniformities are recognized, must depend on the frequency and vividness with which they are repeated in conscious experience; when it is seen that, as a matter of fact, the most common, important, conspicuous, concrete, and simple, uniformities were the earliest recognized, because they were experienced oftenest and most distinctly; it will by implication be seen that long after the great mass of phenomena have been generalized, there must remain phenomena which, from their rareness, or unobtrusiveness, or seeming unimportance, or complexity, or abstractness, are still ungeneralized. Thus will be furnished a solution to a difficulty sometimes raised. When it is asked why the universality of law is not already fully established, there will be the answer that the directions in which it is not yet established are those in which its establishment must necessarily be latest. That state of things which is inferable beforehand, is just the state which we find to exist. If such coexistences and sequences as those of Biology and Sociology are not yet reduced to law, the presumption is, not that they are irreducible to law, but that their laws elude our present means of exploration. Having long ago proved uniformity throughout all the lower classes of relations, and having been step by step proving uni-

formity throughout classes of relations successively higher and higher, if we have not yet succeeded with the highest classes, it may be fairly concluded that our powers are at fault, rather than that the uniformity does not exist. And unless we make the absurd assumption that the process of generalization, now going on with unexampled rapidity, has reached its limit, and will suddenly cease, we must infer that ultimately mankind will discover a constant order even among the most involved and obscure phenomena.

THE VALUATION OF EVIDENCE.

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With Spirit-rappings and Table-movings still the rage, and with the belief in Spontaneous Combustion still unextinguished, it seems desirable that something should be said in justification of that general scepticism with which the philosophical meet the alleged wonders that periodically turn the heads of the nation. Nothing less than a bulky octavo would be needed to contain all that might be written on the matter; and unfortunately such an octavo, when written, would be little read by those most requiring it. A brief hint or two, however, may find listeners among them.

"I tell you I saw it myself," is the so-thought conclusive assertion with which many a controversy is abruptly ended. Commonly those who make this assertion think that after it nothing remains to be urged; and they are astonished at the unreasonableness of those who still withhold their belief. Though they reject many tales of witchcraft, many ghost stories whose marvels were attested by eye-witnesses —though they have repeatedly seen stage-conjurors seem to do things which they do not believe were really done— though they have heard of the Automaton Chess-player and the Invisible Girl, and have perhaps seen explanations of the modes in which the public were deluded by them—

though in all these cases they know that the facts were other than the spectators supposed them to be; yet they cannot imagine that their own perceptions have been vitiated by influences like those which vitiated the perceptions of others. Or, to put the thing more charitably and perhaps more truly, they forget that such vitiations are constantly occurring.

To observe correctly, though commonly thought very easy, every man of science knows to be difficult. Our faculties are liable to report falsely from two opposite causes—the presence of hypothesis, and the absence of hypothesis. To the dangers arising from one or other of these, every observation we make is exposed; and between the two it is hard to see any fact *quite* truly. A few illustrations of the extreme distortions arising from the one cause, and the extreme inaccuracy consequent on the other, will justify this seeming paradox.

Nearly every one is familiar with the myth prevalent on our sea-coasts, respecting the Barnacle Goose. The popular belief was, and indeed is still in some places, that the fruits on branches which hang into the sea become changed into shell-covered creatures called barnacles, found incrusting these submerged branches; and further, that these barnacles are in process of time transformed into the birds known as barnacle geese. This belief was not confined to the vulgar; it was received among naturalists. Nor was it with them simply an adopted rumour. It was based on observations which were recorded and approved by the highest scientific authorities, and published with their countenance. In a paper contained in the *Philosophical Transactions*, Sir Robert Moray says:—"In every shell that I opened . . . there appeared nothing wanting, as to the external parts, for making up a perfect sea-fowl; the little bill like that of a goose, the eyes marked, the head, neck, breast, wings, tail, and feet formed, the feathers everywhere perfectly shaped and blackish coloured, and the feet like those of other water-

fowl, to my best remembrance." Now this myth respecting the barnacle goose has been exploded for some century and a half. To a modern zoologist who examines one of these cirrhipeds, as the barnacles are called, it seems scarcely credible that it could ever have been thought a chick; and what Sir Robert Moray could have taken for "head, neck, breast, wings, tail, feet, and feathers," he cannot imagine. Under the influence of a pre-conception, here is a man of education describing as "a perfect sea-fowl" what is now known to be a modified crustacean—a creature belonging to a remote part of the animal kingdom.

A still more remarkable instance of perverted observation exists in an old book entitled *Metamorphosis Naturalis, &c.*, published at Middleburgh in 1662. This work, in which is attempted for the first time a detailed account of insect-transformations, contains numerous illustrative plates, in which are represented the various stages of evolution—larva, pupa, and imago. Those who have any knowledge of Entomology will recollect that the chrysalises of all our common butterflies exhibit at the anterior end a number of pointed projections, producing an irregular outline. Have they ever observed in this outline a resemblance to a man's face? For myself, I can say that though in early days I kept brood after brood of butterfly larvæ through all their changes, I never perceived any such likeness; nor can I see it now. Nevertheless, in the plates of this *Metamorphosis Naturalis*, each chrysalis has its projections so modified as to represent a burlesque human head—the respective species having different profiles given them. Whether the author was a believer in metempsychosis, and thought he saw in the chrysalis a disguised humanity; or whether, swayed by the false analogy which Butler makes so much of, between the change from chrysalis to butterfly and that from mortality to immortality, he considered the chrysalis as typical of man; does not appear. Here, however, is the fact, that influenced by some pre-

conception or other, he has made his drawings quite different from the actual forms. It is not that he simply thinks this resemblance exists—it is not that he merely says he can see it; but his preconception so possesses him as to swerve his pencil, and make him produce representations laughably unlike the realities.

These, which are extreme cases of distorted perceptions, differ only in degree from the distorted perceptions of daily life; and so strong is the distorting influence that even the man of science cannot escape its effects. Every microscopist knows that if they have conflicting theories respecting its nature, two observers shall look through the same instrument at the same object, and give quite different descriptions of its appearance.

From the dangers of hypothesis let us now turn to the dangers of no hypothesis. Little recognized as is the fact, it is nevertheless true that we cannot make the commonest observation correctly without beforehand having some notion of what we are to observe. You are asked to listen to a faint sound, and you find that without a pre-conception of the *kind* of sound you are to hear, you cannot hear it. Provided that it is not strong, an unusual flavour in your food may pass quite unperceived, unless some one draws attention to it, when you taste it distinctly. After knowing him for years, you shall suddenly discover that your friend's nose is slightly awry, and wonder that you never remarked it before. Still more striking becomes this inability when the facts to be observed are complex. Of a hundred people who listen to the dying vibrations of a church bell, almost all fail to perceive the harmonics, and assert the sound to be simple. Scarcely any one who has not practised drawing, sees, when in the street, that all the horizontal lines in the walls, windows, shutters, roofs, seem to converge to one point in the distance: a fact which, after a few lessons in perspective, becomes visible enough.

Perhaps I cannot more clearly illustrate this necessity for

hypothesis as a condition to accurate perception, than by narrating a portion of my own experience relative to the colours of shadows.

Indian ink was the pigment which, during boyhood, I invariably used for shading. Ask any one who has received no culture in art, or who has given no thought to it, of what colour a shadow is, and the unhesitating reply will be—black. This is uniformly the creed of the uninitiated; and in this creed I undoubtingly remained till about eighteen. Happening, at that age, to come much in contact with an amateur artist, I was told, to my great surprise, that shadows are not black but of a neutral tint. This, to me, novel doctrine, I strenuously resisted. I have a pretty distinct recollection of denying it point blank, and quoting all my experience in support of the denial. I remember, too, that the controversy lasted over a considerable period; and that it was only after my friend had repeatedly drawn my attention to instances in Nature, that I finally gave in. Though I must previously have seen myriads of shadows, yet in consequence of the fact that very generally the tint approaches to black, I had been unable, in the absence of hypothesis, to perceive that in many cases it is distinctly not black.

I continued to hold this amended doctrine for some years. It is true that from time to time I observed that the tone of the neutral tint varied considerably in different shadows; but still the divergencies were not such as to shake my faith in the dogma. By-and-bye, however, in a popular work on Optics, I met with the statement that the colour of a shadow is always the complement of the colour of the light casting it. Not seeing the wherefore of this alleged law, which seemed moreover to conflict with my established belief, I was led to study the matter as a question of causation. *Why* are shadows coloured? and what determines the colour? were the queries that suggested themselves. In seeking answers, it soon became manifest

that as a space in shadow is a space from which the *direct* light alone is excluded, and into which the *indirect* light (namely, that reflected by surrounding objects, by the clouds and by the sky) continues to fall, the colour of a shadow must partake of the colour of everything that can either radiate or reflect light into it. Hence, the colour of a shadow must be *the average colour of the diffused light;* and must vary, as that varies, with the colours of all surrounding things. Thus was at once explained the inconstancy I had already noticed; and I presently recognized in Nature that which the theory implies—namely, that a shadow may have any colour whatever, according to circumstances. Under a clear sky, and with no trees, hedges, houses, or other objects at hand, shadows are of a pure blue. During a red sunset, mixture of the yellow light from the upper part of the western sky with the blue light from the eastern sky, produces green shadows. Go near to a gas-lamp on a moonlight night, and a pencil-case placed at right angles to a piece of paper will be found to cast a purple-blue shadow and a yellow-grey shadow, produced by the gas and the moon respectively. And there are conditions it would take too long here to describe, under which two parts of the same shadow are differently coloured. All which facts became obvious to me as soon as I knew that they must exist.

Here, then, respecting certain simple phenomena that are hourly visible, are three successive convictions; each of them based on years of observation; each of them held with unhesitating confidence; and yet only one—as I now believe—true. But for the help of an hypothesis, I should probably have remained in the common belief that shadows are black. And but for the help of another hypothesis, I should probably have remained in the half-true belief that they are neutral tint.

Is it not clear, therefore, that to observe correctly is by no means easy? On the one hand, a pre-conception, makes

as liable to see things not quite as they are, but as we think them. On the other hand, in the absence of a pre-conception, we are liable to pass over much that we ought to see. Yet we must have either a pre-conception or no pre-conception. Evidently, then, all our observations, save those guided by true theories already reached, are in danger of either distortion or incompleteness.

It remains but to remark, that if our observations are imperfect in cases like the foregoing, where the things seen are persistent, and may be again and again looked at or continuously contemplated; how much more imperfect must they be where the things seen are complex processes, changes, or actions, each presenting successive phases, which, if not truly observed at the moments they severally occur, can never be truly observed at all! Here the chances of error become immensely multiplied. And when, in addition, there exists some moral excitement,—when, as in these Spirit-rapping and Table-turning experiments, the intellect is partially paralysed by fear or wonder, correct observation becomes next to an impossibility.

WHAT IS ELECTRICITY?

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PROBABLY few, if any, competent physicists have, of late years, used the term "electric fluid" in any other than a conventional sense. When distinguishing electricity into the two kinds, "positive" and "negative," or "vitreous" and "resinous," they have used the ideas suggested by these names merely as convenient symbols, and not as representatives of different entities. And, now that heat and light are proved to be modes of motion, it has become obvious that all the allied manifestations of force must be modes of motion.

What is the particular mode of motion which constitutes electricity, thus becomes the question. That it is some kind of molecular vibration, different from the molecular vibrations which luminous bodies give off, is, I presume, taken for granted by all who bring to the consideration of the matter a knowledge of recent discoveries. Beyond those simple oscillations of molecules from which light and heat result, may we not suspect that there will, in some cases, arise compound oscillations? Let us consider whether the conditions under which electricity arises are not such as to generate compound oscillations; and whether the phenomena of electricity are not such as must result from compound oscillations.

The universal antecedent to the production of electricity

is the immediate or mediate contact of heterogeneous substances—substances that are heterogeneous either in their molecular constitutions, or in their molecular states. If, then, electricity is some mode of molecular motion, and if, whenever it is produced, the contact of substances having unlike molecules or molecules in unlike states, is the antecedent, there seems thrust upon us the conclusion that electricity results from some mutual action of molecules whose motions are unlike.

What must be that mutual action of molecules having unlike motions, which, as we see, is the universal antecedent of electrical disturbance? The answer to this question does not seem difficult to reach, if we take the simplest case—the case of contact-electricity. When two pieces of metal of the same kind, and at the same temperature, are applied to one another, there is no electrical excitation; but, if the metals applied to one another be of different kinds, there is a genesis of electricity. This, which has been regarded as an anomalous fact—a fact so anomalous that it has been much disputed because apparently at variance with every hypothesis—is a fact to which an interpretation is at once supplied by the hypothesis that electricity results from the mutual disturbances of unlike molecular motions. For if, on the one hand, we have homogeneous metals in contact, their respective molecules, oscillating synchronously, will give and take any forces which they impress on one another without producing oscillations of new orders. But if, on the other hand, the molecules of the one mass have periods of oscillation different from those of the other mass, their mutual impacts will not agree with the period of oscillation of either, but will generate a new rhythm, differing from, and much slower than, that of either. The production of what are called "beats" in acoustics, will best illustrate this. It is a familiar fact that two strings vibrating at different rates, from time to time concur in sending off aërial waves in the

same direction at the same instant: that then, their vibrations getting more and more out of correspondence, they send off their aërial waves in the same direction at exactly intermediate instants; and presently, coming once more into correspondence, they again generate coinciding waves. So that when their periods of vibration differ but little, and when consequently it takes an appreciable time to complete their alternations of agreement and disagreement, there results an audible alternation in the sound—a succession of pulses of louder and feebler sound. In other words, besides the primary, simple, and rapid series of waves, constituting the two sounds themselves, there is a series of slow compound waves, resulting from their repeated conflicts and concurrences. Now if, instead of the two strings communicating their vibrations to the air, each communicated its vibrations to the other, we should have just the same alternation of concurrent and conflicting pulses. And if each of the two strings was combined with an aggregate of others like itself, in such way that it communicated to its neighbours both its normal and its abnormal vibrations, it is clear that through each aggregate of strings there would be propagated one of these compound waves of oscillation, in addition to their simple rapid oscillations. This illustration will, I think, make it manifest that when a mass of molecules which have a certain period of vibration, is placed in contact with a mass of molecules which have another period of vibration, there must result an alternation of coincidences and antagonisms in the molecular motions, such as will make the molecules alternately increase and decrease one another's motions. There will be instants at which they are moving in the same direction, and intervening instants at which they are moving in opposite directions; whence will arise periods of greatest and least deviations from their ordinary motions. And these greatest and least deviations, being communicated to neighbouring molecules, and passed on by them

to the next, will result in waves of perturbation propagated throughout each mass.

Let us now ask what will be the mutual relations of these waves. Action and reaction being equal and opposite, it must happen that whatever effect a molecule of the mass A produces upon an adjacent molecule of the mass B, must be accompanied by an equivalent reverse effect upon itself. If a molecule of the mass A is at any instant moving in such way as to impress on a molecule of the mass B an additional momentum in any given direction, then the momentum of the molecule of A, in that direction, will be diminished to an equal amount. That is to say, to any wave of increased motion propagated through the molecules of B, there must be a reactive wave of decreased motion propagated in the opposite direction through the molecules of A. See, then, the two significant facts. Any *addition* of motion, which at one of these alternate periods is given by the molecules of A to the molecules of B, must be propagated through the molecules of B in a direction *away from* A; and simultaneously there must be a *subtraction* from the motion of the molecules of A, which will be propagated through them in a direction *away from* B. To every wave of *excess* sent through the one mass, there will be a corresponding wave of *defect* sent through the other; and these *positive* and *negative* waves will be exactly coincident in their times, and exactly equal in their amounts. Whence it follows that if these waves, proceeding from the surface of contact through the two masses in contrary directions, are brought into relation, they will neutralize each other. Action and reaction being equal and opposite, these *plus* and *minus* molecular motions will cancel if they are added together; and there will be a restoration of equilibrium.

These positive and negative waves of perturbation will travel through the two masses of molecules with great facility. It is now an established truth that molecules

absorb, in the increase of their own vibrations, those rhythmical impulses or waves which have periodic times the same as their own; but that they cannot thus absorb successive impulses that have periodic times different from their own. Hence these differential undulations, being very long undulations in comparison with those of the molecules themselves, will readily pass through the masses of molecules, or be *conducted* by them. Further observe that, if the two masses of molecules continue joined, these positive and negative differential waves travelling away from the surface of contact in opposite directions, and severally arriving at the outer surfaces of the two masses, will be reflected from these; and, travelling back again toward the surface of contact, will there meet and neutralize one another. Hence no current will be produced along a wire joining the outer surfaces of the masses; since neutralization will be more readily effected by this return of the waves through the masses themselves. But, though no external current arises, the masses will continue in what we call opposite electric states; as a delicate electrometer shows that they do. And further, if they are parted, the positive and negative waves which have the instant before been propagated through them respectively, remaining unneutralized, the masses will display their opposite electric states in a more conspicuous way. The residual positive and negative waves will then neutralize each other along any conductor that is placed between them, seeing that the *plus* waves communicated from the one mass to the conductor, meeting with the *minus* waves communicated from the other, and being mutually cancelled as they meet, the conductor will become a line of least resistance to the waves of each mass.

Let us pass now to the allied phenomena of thermo-electricity. Suppose these two masses of metal to be heated at their surfaces of contact: the forms of the

masses being such that their surfaces of contact can be considerably heated without their remoter parts being much heated. What will happen? Prof. Tyndall has shown, in the cases of various gases and liquids, that, other things equal, when molecules have given to them more of the insensible motion which we call heat, there is no alteration in their periods of oscillation, but an increase in the amplitudes of their oscillations: the molecules make wider excursions in the same times. Assuming that it is the same in solids, it will follow that, when the two metals are heated at their surfaces of contact, the result will be the same as before in respect of the natures and intervals of the differential waves. There will be a change, however, in the strengths of these waves. For, if the two orders of molecules have severally given to them increased quantities of motion, the perturbations which they impress on each other will also be increased. These stronger positive and negative waves of differential motion will, as before, travel through either mass away from the surfaces of contact—that is, toward the cold extremities of the masses. From these cold extremities they will, as before, rebound toward the surfaces of contact; and, as before, will tend thus to equilibriate each other. But they will meet with resistance in thus travelling back. It is a well-ascertained fact that raising the temperatures of metals decreases their conducting powers. Hence, if the two cold ends of the masses be connected by some other mass whose molecules can take on with facility these differential undulations—that is, if the two ends be joined by a conductor, the positive and negative waves will meet and neutralize one another along this conductor, instead of being reflected back to the surfaces of contact. In other words, there will be established a current along the wire joining the two cold ends of the metallic masses.

Carried a step further, this reasoning affords us an explanation of the thermo-electric pile. If a number of

these bars of different metals, as antimony and bismuth, are soldered together, end to end, in alternate order, AB, AB, AB, etc., then, so long as they remain cold, there is no manifestation of an electric current; or, if all the joints are equally heated, there is no manifestation of an electric current beyond that which would arise from any relative coolness of the two ends of the compound bar. But if alternate joints are heated, an electric current is produced in a wire joining the two ends of the compound bar—a current that is intense in proportion to the number of pairs. What is the cause of this? Clearly, so long as all the joints are of the same temperature, the differential waves propagated from each joint toward the two adjacent joints will be equal and opposite to those from the adjacent joints, and no disturbance will be shown. But if alternate joints are heated, the positive and negative differential waves propagated away from them will be stronger than those propagated from the other joints. Hence, if the joint of bar A with bar B be heated, the other end of the bar B, which is joined to A2, not being heated, will receive a stronger differential wave than it sends back. In addition to the wave which its molecules would otherwise induce in the molecules of A2, there is an effect which it conducts from A1; and this extra impulse propagated to the other end of B2 is added to the impulse which its heated molecules would otherwise give to the molecules of A3: and so on throughout the series. The waves being added together, become more violent, and the current through the wire joining the extremities of the series, more intense.

This interpretation of the facts of thermo-electricity will probably be met by the objection that there are, in some cases, thermo-electric currents developed between masses of metal of the same kind, and even between different parts of the same mass. It may be urged that, if unlikeness between the rates of vibration of molecules in contact

is the cause of these electric disturbances; then, heat ought not to produce any electric disturbances when the molecules are of the same kind; since heat does not change the periodic times of molecular vibrations. This objection, which seems at first sight a serious one, introduces us to a confirmation. For where the masses of molecules are homogeneous in all other respects, difference of temperature does *not* generate any thermo-electric current. The junction of hot with cold mercury sets up no electric excitement. In all cases where thermo-electricity is generated between metals of the same kind, there is evidence of heterogeneity in their molecular structures—either one has been hammered and the other not, or one is annealed and the other unannealed. And where the current is between different parts of the same mass, there are differences in the crystalline states of the parts, or differences between the ways in which the parts have cooled after being cast. That is to say, there is proof that the molecules in the two masses, or in different parts of the same mass, are in unlike relations to their neighbours —are in unlike states of tension. Now, however true it may be that molecules of the same kind vibrate at the same rate, whatever may be their temperature, it is obviously true so long only as their motions are not modified by restraining forces. If molecules of the same kind are in one mass arranged into that state which constitutes crystallization, while in another mass they are not thus bound together; or if in the one their molecular relations have been modified by hammering, and in the other not; the differences in the restraints under which they respectively vibrate will affect their rates of vibration. And if their rates of vibration are rendered unequal, then the alleged cause of electrical disturbance comes into existence.

To sum up, may it not be said that by some such action alone can the phenomena of electricity be explained;

and that some such action must inevitably arise under the conditions? On the one hand electricity, being a mode of motion, implies the transformation of some preëxisting motion—implies, also, a transformation such that there are two new kinds of motion simultaneously generated, equal and opposite in their directions—implies, further, that these differ in being *plus* and *minus*, and being therefore capable of neutralizing each other. On the other hand, in the above cases, molecular motion is the only source of motion that can be assigned; and this molecular motion seems calculated, under the circumstances, to produce effects like those witnessed. Molecules vibrating at different rates cannot be brought in juxtaposition without affecting one another's motions. They must affect one another's motions by periodically adding to, or deducting from one another's motions; and any excess of motion which those of the one order receive, must be accompanied by an equivalent defect of motion in those of the other order. When such molecules are units of aggregates placed in contact, they must pass on these perturbations to their neighbours. And so, from the surface of contact, there must be waves of excessive and defective molecular motion, equal in their amounts, and opposite in their directions—waves which must exactly compensate one another when brought into relation.

I have here dealt only with electrical phenomena of the simplest kind. Hereafter I may possibly endeavour to show how this hypothesis furnishes interpretations of other forms of Electricity.

Postscript (1873).—During the nine years which have elapsed since the foregoing essay was published, I have found myself no nearer to such allied interpretations of other forms of Electricity. Though, from time to time, I have recurred to the subject, in the hope of fulfilling the

expectation raised by the closing sentence, yet no clue has encouraged me to pursue the speculation. Only now, when republication of the essay in a permanent form once more brings the question before me, does there occur a thought which appears worth setting down.

The union of two different ideas, not before placed side by side, has generated this thought. In the first number of the *Principles of Biology*, issued in January 1863, and dealing, among other "Data of Biology," with organic matter and the effects of forces upon it, I ventured to speculate about the molecular actions concerned in organic changes, and, among others, those by which light enables plants to take the carbon from carbonic acid (§ 13). Pointing out that the ability of heat to decompose compound molecules, is generally proportionate to the difference between the atomic weights of their component elements, and assuming that components having widely-unlike atomic weights, have widely-unlike motions, and are therefore affected by widely-unlike undulations; the inference drawn was, that in proportion as the rhythms of its components differ, a compound molecule will be unstable in presence of strong etherial undulations acting upon one component more than on the other or others: their movements thus being rendered so incongruous that they can no longer hold together. It was argued, further, that a tolerably-stable compound molecule may, if exposed to strong etherial undulations especially disturbing one of its components, be decomposed when in presence of some unlike molecule having components whose times of oscillation differ less from those of this disturbed component. And a parallel was drawn between the de-oxidation of metals by carbon when exposed to the longer undulations in a furnace, and the de-carbonization of carbonic acid by hydrogen, &c., when exposed to the shorter undulations in a plant's leaves. These ideas I recall chiefly for the purpose of presenting clearly the conception of a compound molecule as containing

diversely-moving components—components having independent and unlike oscillations, in addition to the oscillation of the whole molecule formed by them. The legitimacy of this conception may, I suppose, be assumed. The beautiful experiments by which Prof. Tyndall has proved that light decomposes the vapours of certain compounds, illustrates this ability which the elements of a compound molecule have, severally to take up etherial undulations corresponding to their own; and thus to have their individual movements so increased as to cause disruption of the compound molecule, This, at least, is the interpretation which Prof. Tyndall puts on the facts; and I presume that he puts a kindred interpretation upon the facts he has disclosed respecting the marvellous power possessed by complex-moleculed vapours to absorb heat—the interpretation, namely, that the thermal undulations are, in such vapours, taken up in augmenting the movements within each molecule, rather than in augmenting the movements of the molecules as wholes.

But now, assuming this to be a true conception of compound molecules and the effects produced on them by etherial undulations, there presents itself the question—What will be the effects produced by compound molecules on one another? How will the elements of one compound molecule have their rhythmical motions affected by proximity to the elements of an unlike compound molecule? May we not suspect that effects will be produced on one another, not only by the unlike molecules as wholes, but also certain other, and partially-independent, effects by their components on one another; and that there will so be generated some specialized form of molecular motion? Throughout the speculation set forth in the foregoing essay, the supposition is that the molecules are those of juxtaposed metals—molecules which, whether absolutely simple or not, are relatively simple; and these are regarded as producing on one another's movements perturbations of a relatively-simple kind, which admit of being transferred from molecule

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to molecule throughout each mass. In trying to carry further this interpretation, it had not occurred to me until now, to consider the perturbations produced on one another by compound molecules: taking into consideration, not merely the capacity each has for affecting the other as a whole, but the capacity which the constituents of each individually have for affecting the individual constituents of the other. If an individual constituent of a compound molecule can, by the successive impacts of etherial undulations, have the amplitudes of its oscillations so increased as to detach it; we can scarcely doubt that an individual constituent of a compound molecule may affect an individual constituent of an unlike compound molecule near it: their respective oscillations perturbing one another apart from the perturbation produced on one another by the compound molecules as wholes. And it seems inferable that the secondary perturbation thus arising, will, like the primary perturbation, be such that the action and reaction, equal and opposite in their amounts, will produce equal and opposite deviations in the molecular movements. From this there appear to be several corollaries.

If a compound molecule, having a slow rhythm as a whole in addition to the more rapid rhythms of its members, has the power of taking up much of that motion we call heat in the increase of its internal movements, and to a corresponding degree takes up less in the increase of its movements as a whole; then may we not infer that the like will hold when other kinds of forces are brought to bear on it? May we not anticipate that when a mass of compound molecules of one kind is made to act upon a mass of compound molecules of another kind (say by friction), the molecular effects mutually produced, partly in agitating the molecules as wholes, and partly in agitating their components relatively to one another, will become less of the first and more of the last, in proportion as the molecules progress in compositeness?

A further implication suggests itself. While much of the

force mutually exercised will thus go to increase the motion within each of the compound molecules that immediately act on one another, it appears inferable that relatively little of this intestinal motion will be communicated to other molecules. The excesses of oscillation given to individual members of a large cluster, will not be readily passed on to homologous members of adjacent large clusters; since they must be relatively far apart. Whatever motion is transferred, must be transferred by waves of the intervening etherial medium; and the power of these must decrease rapidly as the distance increases. Obviously such difficulty of transfer must, for this reason, become great when the molecules become highly compounded.

At the same time will it not follow that such augmentations of movement caused in individual members of a cluster, not being readily transmissible to homologous members of adjacent clusters, will accumulate? The more composite molecules become, the more possible will it be for individual components of them to be violently affected by individual components of different composite molecules near them—the more possible will it be for their mutual perturbations to progressively increase?

And now let us consider how these inferences bear on the interpretation of Statical Electricity—the form of Electricity most unlike the form above dealt with.

The substances which exhibit most conspicuously the phenomena of statical electricity are distinguished either by the chemical complexity of their molecules, or else by the compositeness of their molecules produced allotropically or isomerically, or else by both. The simple substances electrically excited by friction, as carbon and sulphur, are those having several allotropic states—those capable of forming multiple molecules. The conchoidal fracture of the diamond and of roll-sulphur, suggest some colloidal form of aggregation, regarded by Prof. Graham as a form in which the molecules are united into relatively-

large groups.* In such compound inorganic substances as glass, we have, besides the chemical complexity, this same conchoidal fracture which, along with other evidence, shows glass to be a colloid; and the colloidal form of molecule is to be similarly inferred as characterizing resin, amber, &c. That dry animal substances, such as silk and hair, are formed of extremely-large molecules, we have clear proof; since these, chemically complex in a high degree, also have their components united in high multiples. It needs but to name the fact that non-electric and conducting substances, such as the metals, acids, water, &c., have relatively-simple molecules, to make it clear that the capacity for developing statical electricity depends in some way upon the presence of molecules of highly composite kinds. And there is even still more conclusive proof than that yielded by the contrast between these groups—the proof furnished by the fact that the same substance may be a conductor or a non-conductor, according to its form of molecular aggregation. Thus selenium when crystalline is a conductor, but when in that allotropic state called amorphous, or non-crystalline, it is a good non-conductor. That is, accepting Prof. Graham's interpretation of these states, when its molecules are arranged simply, it is a conductor, but when they are compounded into large groups it is a non-conductor, and, by implication, an electric.

So far, then, the *a priori* inference that a peculiar form of molecular perturbation will result when two unlike substances, one of which or each of which consists of

* Though conchoidal fracture may not be conclusive proof of colloidality, yet colloidal substances hard enough for fracture always display it. Respecting roll-sulphur I may say that though in a few days after it is made, it changes from its original state to a state in which it consists of minute crystals of another kind irregularly massed, yet there is reason for suspecting that these have a matrix of amorphous sulphur. I learn from Dr. Frankland that, when sublimed, sulphur aggregates partly into minute crystals and partly into an amorphous powder distinguished by insolubility.

highly-compounded molecules, are made to act on one another, is justified *a posteriori*. And now, instead of asking generally what will happen, let us ask what may be inferred to happen in a special case. A piece of glass is rubbed by silk. The large colloidal molecules forming the surface of each, are made to disturb one another. This is an inference about which there will, I suppose, be no dispute; since it is that assumed in the now-established doctrine of the correlation of heat and motion. Besides the effect which, as wholes the molecules mutually produce, there is the effect produced on one another by certain of their components. Such of these as have times of oscillation which differ, but not very widely, generate mutual perturbations that are equal and opposite. Could these perturbations be readily propagated away from the surface of contact through either mass, the effect would quickly dissipate, as in the case of metals; but, for the reason given above, these perturbations cannot be transferred with ease to the homologous members of the compound molecules behind. Hence the mechanical force of the friction, transformed into the molecular movements of these superficial constituent molecules, exists in them as *intense* mutual perturbations, which, unable to diffuse, are limited to the surfaces, and, indeed, to those parts of the surfaces that have acted on one another. In other words, the two surfaces become charged with two equal and opposite molecular perturbations—perturbations which, cancelling one another if the surfaces are kept in contact, cannot do this if the surfaces are parted; but can then cancel one another only if a conductor is interposed.

Let me briefly point out some apparent agreements between the corollaries from this hypothesis, and the observed phenomena.

We have, first, an interpretation of the fact, otherwise seeming so anomalous, that this form of electrical excitement is *superficial*. That there should be a mode of

activity limited to the surface of a substance, is difficult to understand in the absence of some conception of the kind suggested.

We have an explanation of the truth, insisted on by Faraday, that there can be no charge of one kind of electricity obtained, without a corresponding charge of the opposite kind. For it is a necessary implication of the hypothesis above set forth, that no molecular perturbation of the nature described, can be produced, without there being simultaneously produced a counter-perturbation exactly equal to it.

May we not also say that some insight is afforded into the phenomena of induction? In the cases thus far considered, the two surfaces electrified by the mutual perturbations of their molecules, are supposed to be in contact. Since, however, apparent contact is not actual contact, we must, even in this case, assume that the mutual perturbation is effected through an intervening stratum of ether. To interpret induction, then, we have first to conceive this stratum of ether to be greatly increased in thickness; and then to ask what will happen if the molecules of one surface, in this state of extreme internal perturbation, act on the molecules of a surface near it. Whether the stratum of ether is so thin as to be inappreciable to our senses, or whether it is wide enough to be conspicuous, it must still happen that if through it the mutual perturbations are conveyed in the one case, they will be conveyed in the other; and hence a surface which is already the seat of these molecular perturbations of one order, will induce perturbations of a counter order in the molecules of an adjacent surface.

In additional justification of the hypothesis, I will only point out that voltaic electricity seems to admit of a kindred interpretation. For any molecular re-arrangement, such as occurs in a chemical decomposition and recombination, implies that the movements of the mole-

cules concerned are mutually perturbed; and their perturbations must conform to the general law already described: the molecules must derange one another's motions in equal and opposite ways, and so must generate *plus* and *minus* derangements that cancel when brought into relation.

Of course I suggest this view simply as one occurring to an outsider. Unquestionably it presents difficulties; as, for instance, that no manifest explanation is yielded by it of electric attractions and repulsions. And there are doubtless objections not obvious to me that will at once strike those to whom the facts are more familiar. The hypothesis must be regarded as speculative; and as set down on the chance that it may be worth consideration.

Since the foregoing postscript was put in type, I have received criticisms upon it, oral and written, from several leading electricians and physicists; and I have profited by them to amend parts of the exposition. While I have remained without endorsements of the hypothesis, the objections raised have not been such as to make clear its untenability.

On one point an addition seems needful to exclude a misconstruction apt to arise. The description of the mutually-produced molecular perturbations, opposite in their kinds, as resulting in waves that are propagated away from the place of disturbance, and that cancel when brought into relation, is met by the criticism that waves, proceeding in opposite directions and meeting, do not mutually cancel, but, passing one another, proceed onwards. There are, however, two respects in which the parallelism does not hold, between the waves referred to and the waves I have described, which perhaps cannot rightly be called waves. The waves referred to, as those on the surface of a liquid,

are such that each consists of two opposite deviations from a mean state. Each shows excess and defect. A series of them is a series of *plus* and *minus* divergences; and if two such series meet one another, they do not cancel. But there is no analogy between this case and a case in which the whole effect propagated in one direction is a *plus* motion, and the whole effect propagated in the opposite direction is a *minus* motion—that is, *plus* and *minus* changes in other motions. These, if equal in amount, will cancel when they meet. If one is a continual addition to motion in a certain direction, and the other a corresponding subtraction from motion in that direction, the two, when added together, must produce zero. From another point of view the absence of parallelism between the two cases may be equally well seen. Waves of the kinds instanced as not cancelling one another, are waves produced by some force foreign to the medium exhibiting them—an extrinsic force. Hence, proceeding from the place of initiation, they are necessarily, considered in their totalities, *positive* in whatever directions they travel; and hence, too, when conducted round so as to meet, an exaggerated perturbation will result. But in the simplest of the cases here dealt with that of contact-electricity) the perturbation is not of extrinsic origin, but of intrinsic origin. There is no external activity at the expense of which the quantity of motion in the disturbed matter is positively increased. The activity, being such only as is internally possessed, can generate no more motion than already exists; and therefore whatever gain of motion arises anywhere in the molecules must be at the cost of an equal loss elsewhere. Here perturbation cannot be a *plus* motion in all directions from the place of initiation; but any *plus* motion continually generated can result only from an equal and opposite *minus* motion continually generated; and the mutual cancelling becomes a corollary from the mutual genesis.

In the course of the discussions which I have had, the

following way of presenting the argument has occurred to me.

1. Two homogeneous bodies are rubbed together and there results heat: the interpretation being that the molar motion is transformed into molecular motion. Here motion produces motion—the *form* only being changed.

2. Now of the two bodies one is replaced by a body unlike in nature to the other, and they are again rubbed. Again a certain amount of heat is produced: some of the molar motion is, as before, transformed into molecular motion. But, at the same time, another part of the molar motion is changed into—what? Surely not a fluid, a substance, a thing. It cannot be that what in the first case produces a change of *state*, in the second case produces an *entity*. And in the second case itself, it cannot be that while part of the original motion becomes changed into another species of motion, part of it becomes changed into a species of matter.

3. Must we not say, then, that if, when the two bodies rubbed are homogeneous, sensible motion is transformed into insensible motion, when they are heterogeneous, sensible motion must still be transformed into insensible motion: such difference of nature as this insensible motion has, being consequent on the difference of nature between the two kinds of molecules acting on one another?

4. If, when the two masses are homogeneous, those molecules which compose the two rubbed surfaces disturb one another, and increase one another's oscillations; then, when the two masses are heterogeneous, those molecules forming the two rubbed surfaces must also disturb one another in some way—increase one another's agitations.

5. If, when the two sets of molecules are alike in kind, the mutual disturbance is such that they simply increase the amplitudes of one another's oscillations, and do this because their times correspond; then, must it not be

that when they are unlike in kind, the mutual disturbance will involve a differential action consequent on the unlikeness of their motions? Must not the discord of the oscillations produce a result which cannot be produced when the oscillations are concordant—a compound form of molecular motion?

6. If masses of relatively-simple molecules, placed in apposition and made to act on one another, cause such effects; then must we not say that effects of the same class, but of a different order, will be caused by the mutual actions, not of the molecules as wholes, but of their constituents? If the rubbed surfaces severally consist of highly-compounded molecules—each containing, it may be, several hundreds of minor molecules, united into a definitely-arranged cluster; then, while the molecules as wholes affect one another's motions, must we not infer that the constituents of the one class will affect the constituents of the other class in their motions? While the molecules as wholes increase one another's oscillations, or derange one another's oscillations, or both, the components of them cannot be so stably arranged that members of the one group are wholly inoperative on members of the other group. And if they are operative, then there must be a compound form of molecular motion which arises when masses of highly-compounded molecules of unlike kinds, are made to act on one another.

With this series of propositions and questions, I leave the suggestion to its fate; merely remarking that, setting out with the principles of molecular physics now accepted, it seems difficult to avoid the implication that some actions of the kinds described take place, and that there result from them some classes of phenomena—phenomena which, if not those we call electrical, remain to be identified.

MILL *versus* HAMILTON—THE TEST OF TRUTH.

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BRITISH speculation, to which, the chief initial ideas and established truths of Modern Philosophy are due, is no longer dormant. By his *System of Logic*, Mr. Mill probably did more than any other writer to re-awaken it. And to the great service he thus rendered some twenty years ago, he now adds by his *Examination of Sir William Hamilton's Philosophy*—a work which, taking the views of Sir William Hamilton as texts, reconsiders sundry ultimate questions that still remain unsettled.

Among these questions is one of much importance which has already been the subject of controversy between Mr. Mill and others; and this question I propose to discuss afresh. Before doing so, however, it will be desirable to glance at two cardinal doctrines of the Hamiltonian philosophy from which Mr. Mill shows reasons for dissenting—desirable, because comment on them will elucidate what is to follow.

In his fifth chapter, Mr. Mill points out that "what is rejected as knowledge by Sir William Hamilton," is "brought back by him under the name of belief." The quotations justify this description of Sir W. Hamilton's position, and warrant the assertion that the relativity of

knowledge was held by him but nominally. His inconsistency may, I think, be traced to the use of the word "belief" in two quite different senses. We commonly say we "believe" a thing for which we can assign preponderating evidence, or concerning which we have received some indefinable impression. We *believe* that the next House of Commons will not abolish Church-rates; or we *believe* that a person on whose face we look is good-natured. That is, when we can give confessedly-inadequate proofs or no proofs at all for the things we think, we call them "beliefs." And it is the peculiarity of these beliefs, as contrasted with cognitions, that their connexions with antecedent states of consciousness may be easily severed, instead of being difficult to sever. But, unhappily, the word "belief" is also applied to each of those temporarily or permanently indissoluble connexions in consciousness, for the acceptance of which the only warrant is that it cannot be got rid of. Saying that I feel a pain, or hear a sound, or see one line to be longer than another, is saying that there has occurred in me a certain change of state; and it is impossible for me to give a stronger evidence of this fact than that it is present to my mind. Every argument, too, is resolvable into successive affections of consciousness which have no warrants beyond themselves. When asked why I assert some mediately known truth, as that the three angles of a triangle are equal to two right angles, I find that the proof may be decomposed into steps, each of which is an immediate consciousness that certain two quantities or two relations are equal or unequal—a consciousness for which no further evidence is assignable than that it exists in me. Nor, on finally getting down to some axiom underlying the whole fabric of demonstration, can I say more than that it is a truth of which I am immediately conscious. But now observe the confusion that has arisen. The immense majority of truths which we accept as beyond doubt, and from which our notion of unquestionable truth is abstracted,

have this other trait in common—they are severally established by affiliation on deeper truths. These two characters have become so associated, that one seems to imply the other. For each truth of geometry we are able to assign some wider truth in which it is involved; for that wider truth we are able, if required, to assign some still wider; and so on. This being the general nature of the demonstration by which exact knowledge is established, there has arisen the illusion that knowledge so established is knowledge of higher validity than that immediate knowledge which has nothing deeper to rest on. The habit of asking for proof, and having proof given, in all these multitudinous cases, has produced the implication that proof may be asked for those ultimate dicta of consciousness into which all proof is resolvable. And then, because no proof of these can be given, there arises the vague feeling that they are akin to other things of which no proof can be given—that they are uncertain—that they have unsatisfactory bases. This feeling is strengthened by the accompanying misuse of words. "Belief" having, as above pointed out, become the name of an impression for which we can give only a confessedly-inadequate reason, or no reason at all; it happens that when pushed hard respecting the warrant for any ultimate dictum of consciousness, we say, in the absence of all assignable reason, that we *believe* it. Thus the two opposite poles of knowledge go under the same name; and by the reverse connotations of this name, as used for the most coherent and least coherent relations of thought, profound misconceptions have been generated. Here, it seems to me, is the source of Sir William Hamilton's error. Classing as "beliefs" those direct, undecomposable dicta of consciousness which transcend proof, he asserts that these are of higher authority than knowledge (meaning by knowledge that for which reasons can be given); and in asserting this he is fully justified. But when he claims equal authority for those affections of consciousness which

go under the same name of "beliefs," but differ in being extremely-indirect affections of consciousness, or not definite affections of consciousness at all, the claim cannot be admitted. By his own showing, no positive cognition answering to the word "infinite" exists; while, contrariwise, those cognitions which he rightly holds to be above question, are not only positive, but have the peculiarity that they cannot be suppressed. How, then, can the two be grouped together as of like degrees of validity?

Nearly allied in nature to this, is another Hamiltonian doctrine, which Mr. Mill effectively combats. I refer to the corollary respecting noumenal existence which Sir William Hamilton draws from the law of the Excluded Middle, or, as it might be more intelligibly called, the law of the Alternative Necessity. A thing must either exist or not exist—must have a certain attribute or not have it: there is no third possibility. This is a postulate of all thought; and in so far as it is alleged of phenomenal existence, no one calls it in question. But Sir William Hamilton, applying the formula beyond the limits of thought, draws from it certain conclusions respecting things as they are, apart from our consciousness. He says, for example, that though we cannot conceive Space as infinite or as finite, yet, "on the principle of the Excluded Middle, one or other must be admitted." This inference Mr. Mill shows good reason for rejecting. His argument may be supplemented by another, which at once suggests itself if from the words of Sir William Hamilton's propositions we pass to the thoughts for which they are supposed to stand. When remembering a certain thing as in a certain place, the place and the thing are mentally represented together; while to think of the non-existence of the thing in that place, implies a consciousness in which the place is represented but not the thing. Similarly, if, instead of thinking of an object as colourless, we think of it as having colour, the change consists in the addition to the

concept of an element that was before absent from it—the object cannot be thought of first as red and then as not red, without one component of the thought being expelled from the mind by another. The doctrine of the Excluded Middle, then, is simply a generalization of the universal experience that some mental states are directly destructive of other states. It formulates a certain absolutely-constant law, that no positive mode of consciousness can occur without excluding a correlative negative mode; and that the negative mode cannot occur without excluding the correlative positive mode: the antithesis of positive and negative, being, indeed, merely an expression of this experience. Hence it follows that if consciousness is not in one of the two modes, it must be in the other. But now, under what conditions only can this law of consciousness hold? It can hold only so long as there are positive states of consciousness which can exclude the negative states, and which the negative states can in their turn exclude. If we are not concerned with positive states of consciousness at all, no such mutual exclusion takes place, and the law of the Alternative Necessity does not apply. Here, then, is the flaw in Sir William Hamilton's proposition. That 'Space must be infinite or finite, are alternatives of which we are not obliged to regard one as necessary; seeing that we have no state of consciousness answering to either of these words as applied to the totality of Space, and therefore no exclusion of two antagonist states of consciousness by one another. Both alternatives being unthinkable, the proposition should be put thus: Space is either or is ; neither of which can be conceived, but one of which must be true. In this, as in some other cases, Sir William Hamilton continues to work out the forms of thought when they no longer contain any substance; and, of course, reaches nothing more than verbal conclusions.

Ending here these comments on doctrines of Sir William

Hamilton, which Mr. Mill rejects on grounds that will be generally recognized as valid, let me now pass to a doctrine, partly held by Sir William Hamilton, and held by others in ways variously qualified and variously extended—a doctrine which, I think, may be successfully defended against Mr. Mill's attack.

In the fourth and fifth editions of his *Logic*, Mr. Mill treats, at considerable length, the question—Is inconceivability an evidence of untruth?—replying to criticisms previously made on his reasons for asserting that it is not. The chief answers which he there makes to these criticisms, turn upon the interpretation of the word *inconceivable*. This word he considers is used as the equivalent of the word *unbelievable*; and, translating it thus, readily disposes of sundry arguments brought against him. Whether any others who have used these words in philosophical discussion, have made them synonymous, I do not know; but that they are so used in those reasonings of my own which Mr. Mill combats, I was not conscious, and was surprised to find alleged. It is now manifest that I had not adequately guarded myself against the misconstruction which is liable to arise from the double meaning of the word *belief*—a word which, we have seen, is used for the most coherent and the least coherent connexions in consciousness, because they have the common character that no reason is assignable for them. Throughout the argument to which Mr. Mill replies, the word is used by me only in the first of these senses. The "invariably existent beliefs," the "indestructible beliefs," are the indissoluble connexions in consciousness—never the dissoluble ones. But *unbelievable* implies the dissoluble ones. By association with the other and more general meaning of the word *belief*, the word *unbelievable* suggests cases in which the proposition admits of being represented in thought, though it may be with difficulty; and in which, consequently, the counter-proposition admits of being

decomposed. To be quite sure of our ground, let us define and illustrate the meanings of *inconceivable* and *unbelievable*. An inconceivable proposition is one of which the terms cannot, by any effort, be brought before consciousness in that relation which the proposition asserts between them —a proposition of which the subject and the predicate offer an insurmountable resistance to union in thought. An unbelievable proposition is one which admits of being framed in thought, but is so much at variance with experience that its terms cannot be put in the alleged relation without effort. Thus, it is unbelievable that a cannon-ball fired from England should reach America; but it is not inconceivable. Conversely, it is inconceivable that one side of a triangle is equal to the sum of the other two sides—not simply unbelievable. The two sides cannot be represented in consciousness as becoming equal in their joint length to the third side, without the representation of a triangle being destroyed; and the concept of a triangle cannot be framed without a simultaneous destruction of a concept in which these magnitudes are represented as equal. That is to say, the subject and predicate cannot be united in the same intuition—the proposition is unthinkable. It is in this sense only that I have used the word inconceivable; and only when rigorously restricted to this sense do I regard the test of inconceivableness as having any value.

I had concluded that when this explanation was made, Mr. Mill's reasons for dissent would be removed. Passages in his recently-published volume, however, show that, even restricting the use of the word inconceivable to the meaning here specified, he still denies that a proposition is proved to be true by the inconceivableness of its negation. To meet, within any moderate compass, all the issues which have grown out of the controversy, is difficult. Before passing to the essential question, however, I will endeavour to clear the ground of certain minor questions.

Describing Sir William Hamilton's doctrine respecting

the ultimate facts of consciousness, or those which are above proof, Mr. Mill writes:

"The only condition he requires is that we be not able to 'reduce it [a fact of this class] to a generalization from experience.' This condition is realized by its possessing the 'character of necessity.' 'It must be impossible not to think it. In fact, by its necessity alone can we recognize it as an original datum of intelligence, and distinguish it from any mere result of generalization and custom.' In this Sir William Hamilton is at one with the whole of his own section of the philosophical world; with Reid, with Stewart, with Cousin, with Whewell, we may add, with Kant, and even with Mr. Herbert Spencer. The test by which they all decide a belief to be a part of our primitive consciousness—an original intuition of the mind—is the necessity of thinking it. Their proof that we must always, from the beginning, have had the belief, is the impossibility of getting rid of it now. This argument, applied to any of the disputed questions of philosophy, is doubly illegitimate: neither the major nor the minor premise is admissible. For in the first place, the very fact that the question is disputed, disproves the alleged impossibility. Those against whom it is needful to defend the belief which is affirmed to be necessary, are unmistakable examples that it is not necessary . . . . These philosophers, therefore, and among them Sir William Hamilton, mistake altogether the true conditions of psychological investigation, when, instead of proving a belief to be an original fact of consciousness by shewing that it could not have been acquired, they conclude that it was not acquired, for the reason, often false, and never sufficiently substantiated, that our consciousness cannot get rid of it now."

This representation, in so far as it concerns my own views, has somewhat puzzled me. Considering that I have avowed a general agreement with Mr. Mill in the doctrine that all knowledge is from experience, and have defended

the test of inconceivableness on the very ground that it expresses "the net result of our experiences up to the present time" (*Principles of Psychology*, § 430)—considering that, so far from asserting the distinction quoted from Sir William Hamilton, I have aimed to abolish such distinction—considering that I have endeavoured to show how all our conceptions, even down to those of Space and Time, are "acquired"—considering that I have sought to interpret forms of thought (and by implication all intuitions) as products of organized and inherited experiences (*Principles of Psychology*, § 208); I am taken aback at finding myself classed as in the above paragraph. Leaving the personal question, however, let me pass to the assertion that the difference of opinion respecting the test of necessity itself disproves the validity of the test. Two issues are here involved. First, if a particular proposition is by some accepted as a necessary belief, but by one or more denied to be a necessary belief, is the validity of the test of necessity thereby disproved in respect of that particular proposition? Second, if the validity of the test is disproved in respect of that particular proposition, does it therefore follow that the test cannot be depended on in other cases? —does it follow that there are no beliefs universally accepted as necessary, and in respect of which the test of necessity is valid? Each of these questions may, I think, be rightly answered in the negative.

In alleging that if a belief is said by some to be necessary, but by others to be not necessary, the test of necessity is thereby shown to be no test, Mr. Mill tacitly assumes that all men have powers of introspection enabling them in all cases to say what consciousness testifies; whereas a great proportion of men are incapable of correctly interpreting consciousness in any but its simplest modes, and even the remainder are liable to mistake for dicta of consciousness what prove on closer examination not to be its dicta. Take the case of an arithmetical blunder. A

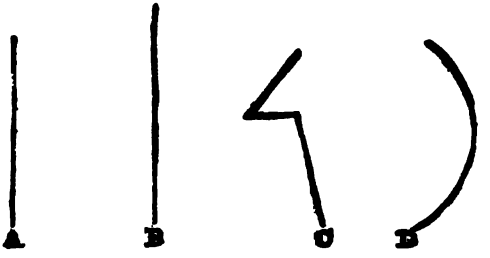
boy adds up a column of figures, and brings out a wrong total. Again he does it and again errs. His master asks him to go through the process aloud, and then hears him say "35 and 9 are 46"—an error which he had repeated on each occasion. Now without discussing the mental act through which we know that 35 and 9 are 44, and through which we recognize the necessity of this relation, it is clear that the boy's misinterpretation of consciousness, leading him tacitly to deny this necessity by asserting that "35 and 9 are 46," cannot be held to prove that the relation is not necessary. This, and kindred misjudgments daily made by accountants, merely show that there is a liability to overlook what are necessary connexions in our thoughts, and to assume as necessary others which are not. In these and hosts of cases, men do not distinctly translate into their equivalent states of consciousness the words they use. This negligence is with many so habitual, that they are unaware that they have not clearly represented to themselves the propositions they assert; and are then apt, quite sincerely though erroneously, to assert that they can think things which it is really impossible to think.

But supposing it to be true that whenever a particular belief is alleged to be necessary, the existence of some who profess themselves able to believe otherwise, proves that this belief is not necessary; must it be therefore admitted that the test of necessity is invalid? I think not. Men may mistake for necessary, certain beliefs which are not necessary; and yet it may remain true that there *are* necessary beliefs, and that the necessity of such beliefs is our warrant for them. Were conclusions thus tested proved to be wrong in a hundred cases, it would not follow that the test is an invalid one; any more than it would follow from a hundred errors in the use of a logical formula, that the logical formula is invalid. If from the premise that all horned animals ruminate, it were inferred that the rhinoceros, being a horned animal, ruminates; the error would

furnish no argument against the worth of syllogisms in general—whatever their worth may be. Daily there are thousands of erroneous deductions which, by those who draw them, are supposed to be warranted by the data from which they draw them; but no multiplication of such erroneous deductions is regarded as proving that there are no deductions truly drawn, and that the drawing of deductions is illegitimate. In these cases, as in the case to which they are here paralleled, the only thing shown is the need for verification of data and criticism of the acts of consciousness.

"This argument," says Mr. Mill, referring to the argument of necessity, "applied to any of the disputed questions of philosophy, is doubly illegitimate; . . . the very fact that the question is disputed, disproves the alleged impossibility." Besides the foregoing replies to this, there is another. Granting that there have been appeals illegitimately made to this test—granting that there are many questions too complex to be settled by it, which men have nevertheless proposed to settle by it, and have consequently got into controversy; it may yet be truly asserted that in respect of all, or almost all, questions legitimately brought to judgment by this test, there is *no* dispute about the answer. From the earliest times on record down to our own, men have not changed their beliefs concerning the truths of number. The axiom that if equals be added to unequals the sums are unequal, was held by the Greeks no less than by ourselves, as a direct verdict of consciousness, from which there is no escape and no appeal. Each of the propositions of Euclid appears to us absolutely beyond doubt as it did to them. Each step in each demonstration we accept, as they accepted it, because we immediately see that the alleged relation is as alleged, and that it is impossible to conceive it otherwise.

But how are legitimate appeals to the test to be distinguished? The answer is not difficult to find. Mr. Mill



cites the belief in the antipodes as having been rejected by the Greeks because inconceivable, but as being held by ourselves to be both conceivable and true. He has before given this instance, and I have before objected to it (*Principles of Psychology*, § 428), for the reason that the states of consciousness involved in the judgment are too complex to admit of any trustworthy verdict being given. An illustration will show the difference between a legitimate appeal to the test and an illegitimate appeal to it. A and B are two lines. How is it decided that they are equal or not equal? No way is open but that of comparing the two impressions they make on consciousness. I know them to be unequal by an immediate act, if the difference is great, or if, though only moderately different, they are close together; and supposing the difference is but slight, I decide the question by putting the lines in apposition when they are movable, or by carrying a movable line from one to the other if they are fixed. But in any case, I obtain in consciousness the testimony that the impression produced by the one line differs from that produced by the other. Of this difference I can give no further evidence than that I am conscious of it, and find it impossible, while contemplating the lines, to get rid of the consciousness. The proposition that the lines are unequal is a proposition of which the negation is inconceivable. But now suppose it is asked whether B and C are equal; or whether C and D are equal. No positive answer is possible. Instead of its being incon-

ceivable that B is longer than C, or equal to it, or shorter, it is conceivable that it is any one of the three. Here an appeal to the direct verdict of consciousness is illegitimate, because on transferring the attention from B to C, or C to D, the changes in the other elements of the impressions so entangle the elements to be compared, as to prevent them from being put in apposition. If the question of relative length is to be determined, it must be by rectification of the bent line; and this is done through a series of steps, each one of which involves an immediate judgment akin to that by which A and B are compared. Now as here, so in other cases, it is only simple percepts or concepts respecting the relations of which immediate consciousness can satisfactorily testify; and as here, so in other cases, it is by resolution into such simple percepts and concepts, that true judgments respecting complex percepts and concepts are reached. That things which are equal to the same thing are equal to one another, is a fact which can be known by direct comparison of actual or ideal relations, and can be known in no other way: the proposition is one of which the negation is inconceivable, and is rightly asserted on that warrant. But that the square of the hypothenuse of a right-angled triangle equals the sum of the squares of the other two sides, cannot be known immediately by comparison of two states of consciousness. Here the truth can be reached only mediately, through a series of simple judgments respecting the likenesses or unlikenesses of certain relations: each of which judgments is essentially of the same kind as that by which the above axiom is known, and has the same warrant. Thus it becomes apparent that the fallacious result of the test of necessity which Mr. Mill instances, is due to a misapplication of the test.

These preliminary explanations have served to make clear the question at issue. Let us now pass to the essence of it.

Metaphysical reasoning is usually vitiated by some covert

petitio principii. Either the thing to be proved or the thing to be disproved, is tacitly assumed to be true in the course of the proof or disproof. It is thus with the argument of Idealism. Though the conclusion reached is that Mind and Ideas are the only existences; yet the steps by which this conclusion is reached, take for granted that external objects have just the kind of independent existence which is eventually denied. If that extension which the Idealist contends is merely an affection of consciousness, has nothing out of consciousness answering to it; then, in each of his propositions concerning extension, the word should always mean an affection of consciousness and nothing more. But if wherever he speaks of distances and dimensions we write ideas of distances and dimensions, his propositions are reduced to nonsense. So, too, is it with Scepticism. The resolution of all knowledge into "impressions" and "ideas," is effected by an analysis which assumes at every step an objective reality producing the impressions and the subjective reality receiving them. The reasoning becomes impossible if the existence of object and subject be not admitted at the outset. Agree with the Sceptic's doubt, and then propose to revise his argument so that it may harmonize with his doubt. Of the two alternatives between which he halts, assume, first, the reality of object and subject. His argument is practicable; whether valid or not. Now assume that object and subject do not exist. He cannot stir a step toward his conclusion—nay, he cannot even state his conclusion; for the word "impression" cannot be translated into thought without assuming a thing impressing and a thing impressed.

Though Empiricism, as at present understood, is not thus suicidal, it is open to an analogous criticism on its method, similarly telling against the validity of its inference. It proposes to account for our so-called necessary beliefs, as well as all our other beliefs; and to do this without postulating any one belief as necessary. Bringing

forward abundant evidence that the connexions among our states of consciousness are determined by our experiences—that two experiences frequently recurring together in consciousness, become so coherent that one strongly suggests the other, and that when their joint recurrence is perpetual and invariable, the connexion between them becomes indissoluble; it argues that the indissolubility, so produced, is all that we mean by necessity. And then it seeks to explain each of our so-called necessary beliefs as thus originated. Now could pure Empiricism reach this analysis and its subsequent synthesis without taking any thing for granted, its arguments would be unobjectionable. But it cannot do this. Examine its phraseology, and there arises the question, Experiences of *what?* Translate the word into thought, and it clearly involves something more than states of mind and the connexions among them. For if it does not, then the hypothesis is that states of mind are generated by the experiences of states of mind; and if the inquiry be pursued, this ends with initial states of mind which are not accounted for—the hypothesis fails. Evidently, there is tacitly assumed something beyond the mind by which the "experiences" are produced—something in which exist the objective relations to which the subjective relations correspond—an external world. Refuse thus to explain the word "experiences," and the hypothesis becomes meaningless. But now, having thus postulated an external reality as the indispensable foundation of its reasonings, pure Empiricism can subsequently neither prove nor disprove its postulate. An attempt to disprove it, or to give it any other meaning than that originally involved, is suicidal; and an attempt to establish it by inference is reasoning in a circle. What then are we to say of this proposition on which Empiricism rests? Is it a necessary belief, or is it not? If necessary, the hypothesis in its pure form is abandoned. If not necessary—if not posited

a priori as absolutely certain—then the hypothesis rests on an uncertainty; and the whole fabric of its argument is unstable. More than this is true. Besides the insecurity implied by building on a foundation that is confessedly not beyond question, there is the much greater insecurity implied by raising proposition upon proposition of which each is confessedly not beyond question. For to say that there are no necessary truths, is to say that each successive inference is not necessarily involved in its premises—is an empirical judgment—a judgment not certainly true. Hence, applying rigorously its own doctrine, we find that pure Empiricism, starting from an uncertainty and progressing through a series of uncertainties, cannot claim much certainty for its conclusions.

Doubtless, it may be replied that any theory of human knowledge must set out with assumptions—either permanent or provisional; and that the validity of these assumptions is to be determined by the results reached through them. But that such assumptions may be made legitimately, two things are required. In the first place they must not be multiplied step after step as occasion requires; otherwise the conclusion reached might as well be assumed at once. And in the second place, the fact that they *are* assumptions must not be lost sight of: the conclusions drawn must not be put forward as though they have a certainty which the premises have not. Now pure Empiricism, in common with other theories of knowledge, is open to the criticism, that it neglects thus avowedly to recognize the nature of those primary assumptions which it lays down as provisionally valid, if it denies that they can be necessarily valid. And it is open to the further criticism, that it goes on at every step in its argument making assumptions which it neglects to specify as provisional; since they, too, cannot be known as necessary. Until it has assigned some warrant for its original datum and for each of its subsequent inferences, or else has ac-

knowledged them all to be but hypothetical, it may be stopped either at the outset or at any stage in its argument. Against every "because" and every "therefore," an opponent may enter a caveat, until he is told why it is asserted: contending, as he may, that if this inference is not necessary he is not bound to accept it; and that if it is necessary it must be openly declared to be necessary, and some test must be assigned by which it is distinguished from propositions that are not necessary.

These considerations will, I think, make it obvious that the first step in a metaphysical argument, rightly carried on, must be an examination of propositions for the purpose of ascertaining what character is common to those which we call unquestionably true, and is implied by asserting their unquestionable truth. Further, to carry on this inquiry legitimately, we must restrict our analysis rigorously to states of consciousness considered in their relations to one another: wholly ignoring any thing beyond consciousness to which these states and their relations may be supposed to refer. For if, before we have ascertained by comparing propositions what is the trait that leads us to class some of them as certainly true, we avowedly or tacitly take for granted the existence of something beyond consciousness; then, a particular proposition is assumed to be certainly true before we have ascertained what is the distinctive character of the propositions which we call certainly true, and the analysis is vitiated. If we cannot transcend consciousness—if, therefore, what we know as truth must be some mental state, or some combination of mental states; it must be possible for us to say in what way we distinguish this state or these states. The definition of truth must be expressible in terms ot consciousness; and, indeed, cannot otherwise be expressed if consciousness cannot be transcended. Clearly, then, the metaphysician's first step must be to shut out from his investigation every thing but what is subjective; not taking for granted the

existence of any thing objective corresponding to his ideas, until he has ascertained what property of his ideas it is which he predicates by calling them true. Let us note the result if he does this.

The words of a proposition are the signs of certain states of consciousness; and the thing alleged by a proposition is the connexion or disconnexion of the states of consciousness signified. When thinking is carried on with precision —when the mental states which we call words, are translated into the mental states they symbolize (which they very frequently are not)—thinking a proposition consists in the occurrence together in consciousness of the subject and predicate. "The bird was brown," is a proposition which implies the union in thought of a particular attribute with a group of other attributes. When the inquirer compares various propositions thus rendered into states of consciousness, he finds that they differ very greatly in respect of the facility with which the states of consciousness are connected and disconnected. The mental state known as *brown* may be united with those mental states which make up the figure known as *bird*, without appreciable effort, or may be separated from them without appreciable effort: the bird may easily be thought of as black, or green, or yellow. Contrariwise, such an assertion as "The ice was hot," is one to which he finds much difficulty in making his mind respond. The elements of the proposition cannot be put together in thought without great resistance. Between those other states of conciousness which the word *ice* connotes, and the state of consciousness named *cold*, there is an extremely strong cohesion—a cohesion measured by the resistance to be overcome in thinking of the ice as *hot*. Further, he finds that in many cases the states of consciousness grouped together cannot be separated at all. The idea of pressure cannot be disconnected from the idea of something occupying space. Motion cannot be thought

of without an object that moves being at the same time thought of. And then, besides these connexions in consciousness which remain absolute under all circumstances, there are others which remain absolute under special circumstances. Between the elements of those more vivid states of consciousness which the inquirer distinguishes as perceptions, he finds that there is a temporarily-indissoluble cohesion. Though when there arises in him that comparatively faint state of consciousness which he calls the idea of a book, he can easily think of the book as red, or brown, or green; yet when he has that much stronger consciousness which he calls seeing a book, he finds that so long as there continue certain accompanying states of consciousness which he calls the conditions to perception, those several states of consciousness which make up the perception cannot be disunited—he cannot think of the book as red, or green, or brown; but finds that, along with a certain figure, there absolutely coheres a certain colour.

Still shutting himself up within these limits, let us suppose the inquirer to ask himself what he thinks about these various degrees of cohesion among his states of consciousness—how he names them, and how he behaves toward them. If there comes, no matter whence, the proposition—"The bird was brown," subject and predicate answering to these words spring up together in consciousness; and if there is no opposing proposition, he unites the specified and implied attributes without effort, and believes the proposition. If, however, the proposition is—"The bird was necessarily brown," he makes an experiment like those above described, and finding that he can separate the attribute of brownness, and can think of the bird as green or yellow, he does not admit that the bird was necessarily brown. When such a proposition as "The ice was cold" arises in him, the elements of the thought behave as before; and so long as no test is applied, the union of the consciousness of cold with the

accompanying states of consciousness, seems to be of the same nature as the union between those answering to the words *brown* and *bird*. But should the proposition be changed into—"The ice was necessarily cold," quite a different result happens from that which happened in the previous case. The ideas answering to subject and predicate are here so coherent, that in the absence of careful examination they might pass as inseparable, and the proposition be accepted. But suppose the proposition is deliberately tested by trying whether ice can be thought of as not cold. Great resistance is offered in consciousness to this. Still, by an effort, he can imagine water to have its temperature of congelation higher than blood heat; and can so think of congealed water as hot instead of cold. Now the extremely strong cohesion of states of consciousness, thus experimentally proved by the difficulty of separating them, he finds to be what he calls a strong belief. Once more, in response to the words—"Along with motion there is something that moves," he represents to himself a moving body; and, until he tries an experiment upon it, he may suppose the elements of the representation to be united in the same way as those of the representations instanced above. But supposing the proposition is modified into—"Along with motion there is necessarily something that moves," the response made in thought to these words, discloses the fact that the states of consciousness called up in this case are indissolubly connected in the way alleged. He discovers this by trying to conceive the negation of the proposition—by trying to think of motion as *not* having along with it something that moves; and his inability to conceive this negation is the obverse of his inability to tear asunder the states of consciousness which constitute the affirmation. Those propositions which survive this strain, are the propositions he distinguishes as necessary. Whether or not he means any thing else by this word, he evidently means that in his consciousness the connexions

they predicate are, so far as he can ascertain, unalterable. The bare fact is that he submits to them because he has no choice. They rule his thoughts whether he will or not. Leaving out all questions concerning the origin of these connexions—all theories concerning their significations, there remains in the inquirer the consciousness that certain of his states of consciousness are so welded together that all other links in the chain of consciousness yield before these give way.

Continuing rigorously to exclude everything beyond consciousness, let him now ask himself what he means by reasoning? what is the essential nature of an argument? what is the peculiarity of a conclusion? Analysis soon shows him that reasoning is the formation of a coherent series of states of consciousness. He has found that the thoughts expressed by propositions, vary in the cohesions of their subjects and predicates; and he finds that at every step in an argument, carefully carried on, he tests the strengths of all the connexions asserted and implied. He considers whether the object named really does belong to the class in which it is included—tries whether he can think of it as *not* like the things it is said to be like. He considers whether the attribute alleged is really possessed by all members of the class—tries to think of some member of the class that has *not* the attribute—And he admits the proposition only on finding, by this criticism, that there is a greater degree of cohesion in thought between its elements, than between the elements of the counter-proposition. Thus testing the strength of each link in the argument, he at length reaches the conclusion, which he tests in the same way. If he accepts it, he does so because the argument has established in him an indirect cohesion between states of consciousness that were not directly coherent, or not so coherent directly as the argument makes them indirectly. But he accepts it only supposing that the connexion between the two states of consciousness

composing it, is not resisted by some stronger counter-connexion. If there happens to be an opposing argument, of which the component thoughts are felt, when tested, to be more coherent; or if, in the absence of an opposing argument, there exists an opposing conclusion, of which the elements have some direct cohesion greater than that which the proffered argument indirectly gives; then the conclusion reached by this argument is not admitted. Thus, a discussion in consciousness proves to be simply a trial of strength between different connexions in consciousness—a systematized struggle serving to determine which are the least coherent states of consciousness. And the result of the struggle is, that the least coherent states of consciousness separate, while the most coherent remain together—form a proposition of which the predicate persists in rising up in the mind along with its subject—constitute one of the connexions in thought which is distinguished as something known, or as something believed, according to its strength.

What corollary may the inquirer draw, or rather what corollary must he draw, on pushing the analysis to its limit? If there are any indissoluble connexions, he is compelled to accept them. If certain states of consciousness absolutely cohere in certain ways, he is obliged to think them in those ways. The proposition is an identical one. To say that they are necessities of thought is merely another way of saying that their elements cannot be torn asunder. No reasoning can give to these absolute cohesions in thought any better warrant; since all reasoning, being a process of testing cohesions, is itself carried on by accepting the absolute cohesions; and can, in the last resort, do nothing more than present some absolute cohesions in justification of others—an act which unwarrantably assumes in the absolute cohesions it offers, a greater value than is allowed to the absolute cohesions it would justify. Here, then, the inquirer comes down to an ulti-

mate mental uniformity—a universal law of his thinking. How completely his thought is subordinated to this law, is shown by the fact that he cannot even represent to himself the possibility of any other law. To suppose the connexions among his states of consciousness to be otherwise determined, is to suppose a smaller force overcoming a greater—a proposition which may be expressed in words but cannot be rendered into ideas. No matter what he calls these indestructible relations, no matter what he supposes to be their meanings, he is completely fettered by them. Their indestructibility is the proof to him that his consciousness is imprisoned within them; and supposing any of them to be in some way destroyed, he perceives that indestructibility would still be the distinctive character of the bounds that remained—the test of those which he must continue to think.

These results the inquirer arrives at without assuming any other existence than that of his own consciousness. They postulate nothing about mind or matter, subject or object. They leave wholly untouched the questions—what does consciousness imply? and how is thought generated? There is not involved in the analysis any hypothesis respecting the origin of these relations between thoughts—how there come to be feeble cohesions, strong cohesions, and absolute cohesions. Whatever some of the terms used may have seemed to connote, it will be found, on examining each step, that nothing is essentially involved beyond states of mind and the connexions among them, which are themselves other states of mind. Thus far, the argument is not vitiated by any *petitio principii*.

Should the inquirer enter upon the question, How are these facts to be explained? he must consider how any further investigation is to be conducted, and what is the possible degree of validity of its conclusions. Remembering that he cannot transcend consciousness, he sees that anything in the shape of an interpretation must be subor-

dinate to the laws of consciousness. Every hypothesis he entertains in trying to explain himself to himself, being an hypothesis which can be dealt with by him only in terms of his mental states, it follows that any process of explanation must itself be carried on by testing the cohesions among mental states, and accepting the absolute cohesions. His conclusions, therefore, reached only by repeated recognitions of this test of absolute cohesion, can never have any higher validity than this test. It matters not what name he gives to a conclusion—whether he calls it a belief, a theory, a fact, or a truth. These words can be themselves only names for certain relations among his states of consciousness. Any secondary meanings which he ascribes to them must also be meanings expressed in terms of consciousness, and therefore subordinate to the laws of consciousness. Hence he has no appeal from this ultimate dictum; and seeing this, he sees that the only possible further achievement is the reconciliation of the dicta of consciousness with one another—the bringing all other dicta of consciousness into harmony with this ultimate dictum.

Here, then, the inquirer discovers a warrant higher than that which any argument can give, for asserting an objective existence. Mysterious as seems the consciousness of something which is yet out of consciousness, he finds that he alleges the reality of this something in virtue of the ultimate law—he is obliged to think it. There is an indissoluble cohesion between each of those vivid and definite states of consciousness which he calls a sensation, and an indefinable consciousness which stands for a mode of being beyond sensation, and separate from himself. When grasping his fork and putting food into his mouth, he is wholly unable to expel from his mind the notion of something which resists the force he is conscious of using; and he cannot suppress the nascent thought of an independent existence keeping apart his tongue and palate, and giving

him that sensation of taste which he is unable to generate in consciousness by his own activity. Though self-criticism shows him that he cannot know what this is which lies outside of him; and though he may infer that not being able to say what it is, it is a fiction; he discovers that such self-criticism utterly fails to extinguish the consciousness of it as a reality. Any conclusion into which he argues himself, that there is no objective existence connected with these subjective states, proves to be a mere verbal conclusion to which his thoughts will not respond. The relation survives every effort to destroy it—is proved by experiment, repeated no matter how often, to be one of which the negation is inconceivable; and therefore one having supreme authority. In vain he endeavours to give it any greater authority by reasoning; for whichever of the two alternatives he sets out with, leaves him at the end just where he started. If, knowing nothing more than his own states of consciousness, he declines to acknowledge any thing beyond consciousness until it is proved, he may go on reasoning for ever without getting any further; since the perpetual elaboration of states of consciousness out of states of consciousness, can never produce anything more than states of consciousness. If, contrariwise, he postulates external existence, and considers it as merely postulated, then the whole fabric of his argument, standing upon this postulate, has no greater validity than the postulate gives it, *minus* the possible invalidity of the argument itself. The case must not be confounded with those cases in which an hypothesis, or provisional assumption, is eventually proved true by its agreement with facts; for in these cases the facts with which it is found to agree, are facts known in some other way than through the hypothesis: a calculated eclipse of the moon serves as a verification of the hypothesis of gravitation, because its occurrence is observable without taking for granted the hypothesis of gravitation. But when the external world

is postulated, and it is supposed that the validity of the postulate may be shown by the explanation of mental phenomena which it furnishes, the vice is, that the process of verification is itself possible only by assuming the thing to be proved.

But now, recognizing the indissoluble cohesion between the consciousness of *self* and an unknown *not-self*, as constituting a dictum of consciousness which he is both compelled to accept and is justified by analysis in accepting, it is competent for the inquirer to consider whether, setting out with this dictum, he can base on it a satisfactory explanation of what he calls knowledge. He finds such an explanation possible. The hypothesis that the more or less coherent relations among his states of consciousness, are generated by experience of the more or less constant relations in something beyond his consciousness, furnishes him with solutions of numerous facts of consciousness: not, however, of all, if he assumes that this adjustment of inner to outer relations has resulted from his own experiences alone. Nevertheless, if he allows himself to suppose that this moulding of thoughts into correspondence with things, has been going on through countless preceding generations; and that the effects of experiences have been inherited in the shape of modified organic structures; then he is able to interpret all the phenomena. It becomes possible to understand how these persistent cohesions among states of consciousness, are themselves the products of often-repeated experiences; and that even what are known as "forms of thought," are but the absolute internal uniformities generated by infinite repetitions of absolute external uniformities. It becomes possible also to understand how, in the course of organizing of these multiplying and widening experiences, there may arise partially-wrong connexions in thought, answering to limited converse with things; and that these connexions in thought, temporarily taken for indissoluble ones, may afterwards be made dissoluble by presentation

of external relations at variance with them. But even when this occurs, it can afford no ground for questioning the test of indissolubility; since the process by which some connexion previously accepted as indissoluble, is broken, is simply the establishment of some antagonistic connexion, which proves, on a trial of strength, to be the stronger—which remains indissoluble when pitted against the other, while the other gives way. And this leaves the test just where it was; showing only that there is a liability to error as to what *are* indissoluble connexions. From the very beginning, therefore, to the very end of the explanation, even down to the criticism of its conclusions and the discovery of its errors, the validity of this test must be postulated. Whence it is manifest, as before said, that the whole business of explanation can be nothing more than that of bringing all other dicta of consciousness into harmony with this ultimate dictum.

To the positive justification of a proposition, may be added that negative justification which is derived from the untenability of the counter-proposition. When describing the attitude of pure Empiricism, some indications that its counter-proposition is untenable were given; but it will be well here to state, more specifically, the fundamental objections to which it is open.

If the ultimate test of truth is not that here alleged, then what is the ultimate test of truth? And if there is no ultimate test of truth, then what is the warrant for accepting certain propositions and rejecting others? An opponent who denies the validity of this test, may legitimately decline to furnish any test himself, so long as he does not affirm any thing to be true; but if he affirms some things to be true and others to be not true, his warrant for doing so may fairly be demanded. Let us glance at the possible response to the demand. If asked why he holds it to be unquestionably true that two quantities which differ

in unequal degrees from a third quantity are themselves unequal, two replies seem open to him: he may say that this is an ultimate fact of consciousness, or that it is an induction from personal experiences. The reply that it is an ultimate fact of consciousness, raises the question, How is an ultimate fact of consciousness distinguished? All beliefs, all conclusions, all imaginations even, are facts of consciousness; and if some are to be accepted as beyond question because ultimate, while others are not to be accepted as beyond question because not ultimate, there comes the inevitable inquiry respecting the test of ultimacy. On the other hand, the reply that this truth is known only by induction from personal experiences, suggests the query—On what warrant are personal experiences asserted? The testimony of experience is given only through memory; and its worth depends wholly on the trustworthiness of memory. Is it, then, that the trustworthiness of memory is less open to doubt than the immediate consciousness that two quantities must be unequal if they differ from a third quantity in unequal degrees? This can scarcely be alleged. Memory is notoriously uncertain. We sometimes suppose ourselves to have said things which it turns out we did not say; and we often forget seeing things which it is proved we did see. We speak of many passages of our lives as seeming like dreams; and can vaguely imagine the whole past to be an illusion. We can go much further toward conceiving that our recollections do not answer to any actualities, than we can go toward conceiving the non-existence of Space. But even supposing the deliverances of memory to be above criticism, the most that can be said for the experiences to which memory testifies, is that we are obliged to think we have had them—cannot conceive the negation of the proposition that we have had them; and to say this is to assign the warrant which is repudiated.

A further counter-criticism may be made. Throughout the argument of pure Empiricism, it is tacitly assumed that

there may be a Philosophy in which nothing is asserted but what is proved. It proposes to admit into the coherent fabric of its conclusions, no conclusion that is incapable of being established by evidence; and it thus takes for granted that not only may all derivative truths be proved, but also that proof may be given of the truths from which they are derived, down to the very deepest. The result of thus refusing to recognize some fundamental unproved truth, is simply to leave its fabric of conclusions without a base. The giving proof of any special proposition, is the assimilation of it to some class of propositions known to be true. If any doubt arises respecting the general proposition which is cited in justification of this special proposition, the course is to show that this general proposition is deducible from a proposition or propositions of still greater generality; and if pressed for proof of each such still more general proposition, the only resource is to repeat the process. Is this process endless? If so, nothing can be proved—the whole series of propositions depends on some unassignable proposition. Has the process an end? If so, there must eventually be reached a widest proposition—one which cannot be justified by showing that it is included by any wider—one which cannot be proved. Or to put the argument otherwise: Every inference depends on premises; every premise, if it admits of proof, depends on other premises; and if the proof of the proof be continually demanded, it must either end in an unproved premise, or in the acknowledgment that there cannot be reached any premise on which the entire series of proofs depends. Hence Philosophy, if it does not avowedly stand on some datum underlying reason, must acknowledge that it has nothing on which to stand.

The expression of divergence from Mr. Mill on this fundamental question, I have undertaken with reluctance, only on finding it needful, both on personal and on general

grounds, that his statements and arguments should be met. For two reasons, especially, I regret having thus to contend against the doctrine of one whose agreement I should value more than that of any other thinker. In the first place, the difference is, I believe, superficial rather than substantial; for it is in the interests of the Experience-Hypothesis that Mr. Mill opposes the alleged criterion of truth; while it is as harmonizing with the Experience-Hypothesis, and reconciling it with all the facts, that I defend this criterion. In the second place, this lengthened exposition of a single point of difference, unaccompanied by an exposition of the numerous points of concurrence, unavoidably produces an appearance of dissent very far greater than that which exists. Mr. Mill, however, whose unswerving allegiance to truth is on all occasions so conspicuously displayed, will fully recognize the justification for this utterance of disagreement on a matter of such profound importance, philosophically considered; and will not require any apology for the entire freedom with which I have criticised his views while seeking to substantiate my own.

REPLIES TO CRITICISMS.

[*First published in* The Fortnightly Review *for November and December* 1873.]

WHEN made by a competent reader, an objection usually implies one of two things. Either the statement to which he demurs is wholly or partially untrue; or, if true, it is presented in such a way as to permit misapprehension. A need for some change or addition is in any case shown.

Not recognizing the errors alleged, but thinking rather that misapprehensions cause the dissent of those who have attacked the metaphysico-theological doctrines held by me, I propose here to meet, by explanations and arguments, the chief objections urged: partly with the view of justifying these doctrines, and partly with the view of guarding against the wrong interpretations which it appears are apt to be made.

The pages of a periodical intended for general reading may be thought scarcely fitted for the treatment of these highly abstract questions. There is now, however, so considerable a class interested in them, and they are so deeply involved with the great changes of opinion in progress, that I have ventured to hope for readers outside the circle of those who occupy themselves with philosophy.

Of course the criticisms to be noticed I have selected,

either because of their intrinsic force, or because they come from men whose positions or reputations give them weight. To meet more than a few of my opponents is out of the question.

Let me begin with a criticism contained in the sermon preached by the Rev. Principal Caird before the British Association, on the occasion of its meeting in Edinburgh, in August, 1871. Expressed with a courtesy which, happily, is now less rare than of yore in theological controversy, Dr. Caird's objection might, I think, be admitted without involving essential change in the conclusion demurred to; while it might be shown to tell with greater force against the conclusions of thinkers classed as orthodox, Sir W. Hamilton and Dean Mansel, than against my own. Describing this as set forth by me, Dr. Caird says:—

"His thesis is that the provinces of science and religion are distinguished from each other as the known from the unknown and unknowable. This thesis is maintained mainly on a critical examination of the nature of human intelligence, in which the writer adopts and carries to its extreme logical results the doctrine of the relativity of human knowledge which, propounded by Kant, has been reproduced with special application to theology by a famous school of philosophers in this country. From the very nature of human intelligence, it is attempted to be shown that it can only know what is finite and relative, and that therefore the absolute and infinite the human mind is, by an inherent and insuperable disability, debarred from knowing. . . . . May it not be asked, for one thing, whether in the assertion, as the result of an examination of the human intellect, that it is incapable of knowing what lies beyond the finite, there is not involved an obvious self-contradiction? The examination of the mind can be conducted only by the mind, and if the instrument be, as is alleged, limited and defective, the result of the inquiry must partake of that defectiveness. Again, does not the knowledge of a limit imply already the power to transcend it? In affirming that human science is incapable of crossing the bounds of the finite world, is it not a necessary presupposition that you who so affirm have crossed these bounds?"

That this objection is one I am not disinclined to recognize, will be inferred when I state that it is one I have myself raised. While preparing the second edition of the

Principles of Psychology, I found, among my memoranda, a note which still bore the wafers by which it had been attached to the original manuscript (unless, indeed, it had been transferred from the MS. of *First Principles*, which its allusion seems to imply). It was this :—

"I may here remark in passing that the several reasonings, including the one above quoted, by which Sir William Hamilton would demonstrate the pure relativity of our knowledge—reasonings which clearly establish many important truths, and with which in the main I agree—are yet capable of being turned against himself, when he definitely concludes that it is impossible for us to know the absolute. For to positively assert that the absolute cannot be known, is in a certain sense to assert a *knowledge* of it—is to *know* it as *unknowable*. To affirm that human intelligence is confined to the conditioned, is to put an *absolute limit* to human intelligence, and implies *absolute knowledge*. It seems to me that the 'learned ignorance' with which philosophy ends, must be carried a step further; and instead of positively saying that the absolute is unknowable, we must say that we cannot tell whether it is knowable or not."

Why I omitted this note I cannot now remember. Possibly it was because re-consideration disclosed a reply to the contained objection. For while it is true that the intellect cannot prove its own competence, since it must postulate its own competence in the course of the proof, and so beg the question; yet it does not follow that it cannot prove its own incompetence respecting questions of certain kinds. Its inability in respect of such questions has two conceivable causes. It may be that the deliverances of Reason in general are invalid, in which case the incompetence of Reason to solve questions of a certain class is implied by its general incompetence; or it may be that the deliverances of Reason, valid within a certain range, themselves end in the conclusion that Reason is incapable beyond that range. So that while there can be no proof of competence, because competence is postulated in each step of the demonstration, there may be proof of incompetence either (1) if the successive deliverances forming the steps of the demonstration, by severally evolving contradictions, show their untrustworthiness, or (2) if, being trustworthy,

they lead to the result that on certain questions Reason cannot give any deliverance.

Reason leads both inductively and deductively to the conclusion that the sphere of Reason is limited. Inductively, this conclusion expresses the result of countless futile attempts to transcend this sphere—attempts to understand Matter, Motion, Space, Time, Force, in their ultimate natures—attempts which, bringing us always to alternative impossibilities of thought, warrant the inference that such attempts will continue to fail, as they have hitherto failed. Deductively, this conclusion expresses the result of mental analysis, which shows us that the product of thought is in all cases a relation, identified as such or such; that the process of thought is the identification and classing of relations; that therefore Being in itself, out of relation, is unthinkable, as not admitting of being brought within the form of thought. That is to say, deduction explains that failure of Reason established as an induction from many experiments. And to call in question the ability of Reason to give this verdict against itself in respect of these transcendent problems, is to call in question its ability to draw valid conclusions from premises; which is to assert a general incompetence necessarily inclusive of the special incompetence.

Closely connected with the foregoing, is a criticism from Dr. Mansel, on which I may here make some comments. In a note to his *Philosophy of the Conditioned* (p. 39), he says :—

"Mr. Herbert Spencer, in his work on *First Principles*, endeavours to press Sir W. Hamilton into the service of Pantheism and Positivism together" [a somewhat strange assertion, by the way, considering that I reject them both], "by adopting the negative portion only of his philosophy—in which, in common with many other writers, he declares the absolute to be inconceivable by the mere intellect,—and rejecting the positive portions, in which he most emphatically maintains that the belief in a personal God is imperatively demanded by the facts of our moral and emotional consciousness. . . . . Sir W. Hamilton's fundamental principle is, that consciousness

must be accepted entire, and that the moral and religious feelings, which are the primary source of our belief in a personal God, are in no way invalidated by the merely negative inferences which have deluded men into the assumption of an impersonal absolute. . . . . Mr. Spencer, on the other hand, takes these negative inferences as the only basis of religion, and abandons Hamilton's great principle of the distinction between knowledge and belief."

Putting these statements in the order most convenient for discussion, I will deal first with the last of them. Instead of saying what he does, Dr. Mansel should have said that I decline to follow Sir W. Hamilton in confounding two distinct, and indeed radically-opposed, meanings of the word *belief*. This word "is habitually applied to dicta of consciousness for which no proof can be assigned: both those which are unprovable because they underlie all proof, and those which are unprovable because of the absence of evidence."* In the pages of the *Fortnightly Review* for July, 1865, I exhibited this distinction as follows:—

"We commonly say we 'believe' a thing for which we can assign some preponderating evidence, or concerning which we have received some indefinable impression. We *believe* that the next House of Commons will not abolish Church-rates; or we *believe* that a person on whose face we look is good-natured. That is, when we can give confessedly-inadequate proofs, or no proofs at all, for the things we think, we call them 'beliefs.' And it is the peculiarity of these beliefs, as contrasted with cognitions, that their connexions with antecedent states of consciousness may be easily severed, instead of being difficult to sever. But unhappily, the word 'belief' is also applied to each of those temporarily or permanently indissoluble connexions in consciousness, for the acceptance of which the only warrant is that it cannot be got rid of. Saying that I feel a pain, or hear a sound, or see one line to be longer than another, is saying that there has occurred in me a certain change of state; and it is impossible for me to give a stronger evidence of this fact than that it is present to my mind. . . . . 'Belief' having, as above pointed out, become the name of an impression for which we can give only a confessedly-inadequate reason, or no reason at all; it happens that when pushed hard respecting the warrant for any ultimate dictum of consciousness, we say, in the absence of all assignable reason, that we *believe* it. Thus the two opposite poles of knowledge go under the same name; and by the reverse connotations of this name, as used for the most coherent and least coherent relations of thought, profound misconceptions have been generated."

Now that the belief which the moral and religious

* *Principles of Psychology*, Second Edition, § 425, note.

feelings are said to yield of a personal God, is not one of the beliefs which are unprovable because they underlie all proof, is obvious. It needs but to remember that in works on Natural Theology, the existence of a personal God is *inferred* from these moral and religious feelings, to show that it is not contained in these feelings themselves, or joined with them as an inseparable intuition. It is not a belief like the beliefs which I now have that this is daylight, and that there is open space before me—beliefs which cannot be proved because they are of equal simplicity with, and of no less certainty than, each step in a demonstration. Were it a belief of this most certain kind, argument would be superfluous: all races of men and every individual would have the belief in an inexpugnable form. Hence it is manifest that, confusing the two very different states of consciousness called beliefs, Sir W. Hamilton ascribes to the second a certainty that belongs only to the first.

Again, neither Sir W. Hamilton nor Dr. Mansel has enabled us to distinguish those "facts of our moral and emotional consciousness" which imperatively demand the belief in a personal God, from those facts of our (or of men's) "moral and emotional consciousness" which, in those having them, imperatively demand beliefs that Sir W. Hamilton would regard as untrue. A New Zealand chief, discovering his wife in an infidelity, killed the man; the wife then killed herself that she might join her lover in the other world; and the chief thereupon killed himself that he might go after them to defeat this intention. These two acts of suicide furnish tolerably strong evidence that these New Zealanders believed in another world to which they could go at will, and fulfil their desires as they did here. If they were asked the justification for this belief, and if the arguments by which they sought to establish it were not admitted, they might still fall back on emotional

consciousness as yielding them an unshakeable foundation for it. I do not see why a Fiji Islander, adopting the Hamiltonian argument, should not justify by it his conviction that after being buried alive, his life in the other world, forthwith commencing at the age he has reached in this, will similarly supply him with the joys of conquest and the gratifications of cannibalism. That he has a conviction to this effect stronger than the religious convictions current among civilized people, is proved by the fact that he goes to be buried alive quite willingly. And as we may presume that his conviction is not the outcome of a demonstration, it must be the outcome of some state of feeling—some "emotional consciousness." Why, then, should he not assign the "facts" of his "emotional consciousness" as "imperatively demanding" this belief? Manifestly, this principle that "consciousness must be accepted entire," either obliges us to accept as true the superstitions of all mankind, or else obliges us to say that the consciousness of a certain limited class of cultivated people is alone meant. If things are to be believed simply because the facts of emotional consciousness imperatively demand the beliefs, I do not see why the actual existence of a ghost in a house, is not inevitably implied by the intense fear of it that is aroused in the child or the servant.

Lastly, and chiefly, I have to deal with Dr. Mansel's statement that "Mr. Spencer, on the other hand, takes these negative inferences as the only basis of religion." This statement is exactly the reverse of the truth; since I have contended, against Hamilton and against him, that the consciousness of that which is manifested to us through phenomena is *positive*, and not *negative*, as they allege, and that this positive consciousness supplies an indestructible basis for the religious sentiment (*First Principles*, § 26). Instead of giving here passages to show this, I may fitly quote the statement and opinion of a

foreign theologian. M. le pasteur Grotz, of the Reformed Church at Nismes, writes thus :—

"La science serait-elle donc par nature ennemie de la religion? pour être religieux, faut-il proscrire la science?—C'est la science, la science expérimentale qui va maintenant parler en faveur de la religion ; c'est elle qui, par la bouche de l'un des penseurs . . . de notre époque, M. Herbert Spencer, va répondre à la fois à M. Vacherot et à M. Comte."

* * * * *

"Ici, M. Spencer discute la théorie de l'*inconditionné*; entendez par ce mot: Dieu. Le philosophie écossais, Hamilton, et son disciple, M. Mansel, disent comme nos positivistes français: 'Nous ne pouvons affirmer l'existence positive de quoi que ce soit au delà des phénomènes.' Seulement, Hamilton et son disciple se séparent de nos compatriotes en faisant intervenir une 'révélation merveilleuse' qui nous fait croire à l'existence de l'inconditionné, et grâce à cette révélation vraiment merveilleuse, toute l'orthodoxie revient. Est-il vrai que nous ne puissions rien affirmer au delà des phénomènes? M. Spencer déclare qu'il y a dans cette assertion une grave erreur. Le côté logique, dit-il fort justement, n'est pas le seul; il y a aussi le côté psychologique, et, selon nous, il prouve que l'existence positive de l'absolu est une donnée nécessaire de la conscience."

"Là est la base de l'accord entre la religion et la science. Dans un chapitre . . . . intitulé *Réconciliation*, M. Spencer établit et développe cet accord sur son véritable terrain."

* * * * *

"M. Spencer, en restant sur le terrain de la logique et de la psychologie, et sans recourir à une intervention surnaturelle, a établi la legitimité, la nécessité et l'éternelle durée du sentiment religieux et de la religion."*

I turn next to what has been said by Dr. Shadworth H. Hodgson, in his essay on "The Future of Metaphysic," published in the *Contemporary Review* for November, 1872. Remarking only, with respect to the agreements he expresses in certain views of mine, that I value them as coming from a thinker of subtlety and independence, I will confine myself here to his disagreements. Dr. Hodgson, before giving his own view, briefly describes and criticizes the views of Hegel and Comte, with both of whom he partly agrees and partly disagrees, and then

* *Le Sentiment Religieux*, par A. Grotz. Paris, J. Cherbuliez, 1870.

proceeds to criticize the view set forth by me. After a preliminary brief statement of my position, to the wording of which I demur, he goes on to say:—

"In his *First Principles*, Part 1, second ed., there is a chapter headed 'Ultimate Scientific Ideas,' in which he enumerates six such ideas or groups of ideas, and attempts to show that they are entirely incomprehensible. The six are:—1. Space and Time. 2. Matter. 3. Rest and Motion. 4. Force 5. Consciousness. 6. The Soul, or the Ego. Now to enter at length into all of these would be an undertaking too large for the present occasion; but I will take the first of the six, and endeavour to show in its case the entire untenability of Mr. Spencer's view; and since the same arguments may be employed against the rest, I shall be content that my case against them should be held to fail if my case should fail in respect to Space and Time."

I willingly join issue with Dr. Hodgson on these terms; and proceed to examine, one by one, the several arguments he uses to show the invalidity of my conclusions. Following his criticisms in the order he has chosen, I begin with the sentence following that which I have just quoted. The first part of it runs thus:—"The metaphysical view of Space and Time is, that they are elements in all phenomena, whether the phenomena are presentations or representations."

Whether, by "the metaphysical view," is here meant the view of Kant, whether it means Dr. Hodgson's own view, or whether the expression has a more general meaning, I have simply to reply that the metaphysical view is incorrect. Dealing with the Kantian version of this doctrine, that Space is a form of intuition, I have pointed out that only with certain classes of phenomena is Space united indissolubly; that Kant habitually considers phenomena belonging to the visual and tactual groups, with which the consciousness of space is inseparably joined, and overlooks groups with which it is not inseparably joined. Though in the adult, perception of sound has certain space-implications, mostly, if not wholly, acquired by individual experience; and though it would seem from the instructive experiments of Mr. Spalding, that in creatures born with nervous systems much more organized than our own are at birth,

there is some innate perception of the side from which a sound comes; yet it is demonstrable that the space-implications of sound are not originally given with the sensation as its form of intuition. Bearing in mind the Kantian doctrine, that Space is the form of sensuous intuitions not only as *presented* but also as *represented*, let us examine critically our musical ideas. As I have elsewhere suggested to the reader—

"Let him observe what happens when some melody takes possession of his imagination. Its tones and cadences go on repeating themselves apart from any space-consciousness—they are not localized. He may or may not be reminded of the place where he heard them—this association is incidental only. Having observed this, he will see that such space-implications as sounds have, are learnt in the course of individual experience, and are not given with the sounds themselves. Indeed, if we refer to the Kantian definition of form, we get a simple and conclusive proof of this. Kant says form is 'that which effects that the content of the phænomenon can be arranged under certain relations.' How then can the content of the phenomenon we call sound be arranged? Its parts can be arranged in order of sequence—that is, in Time. But there is no possibility of arranging its parts in order of coexistence—that is, in Space. And it is just the same with odour. Whoever thinks that sound and odour have Space for their form of intuition, may convince himself to the contrary by trying to find the right and left sides of a sound, or to imagine an odour turned the other way upwards."—*Principles of Psychology*, § 399.—Note.

As I thus dissent, not I think without good reason, from "the metaphysical view of Space and Time" as "elements in all phenomena," it will naturally be expected that I dissent from the first criticism which Dr. Hodgson proceeds to deduce from it. Dealing first with the arguments I have used to show the incomprehensibility of Space and Time, if we consider them as objective, and stating in other words the conclusion I draw, that "as Space and Time cannot be either nonentities nor the attributes of entities, we have no choice but to consider them as entities." Dr. Hodgson continues:—

"So far good. Secondly, he argues that they cannot be represented in thought as such real existences, because 'to be conceived at all, a thing must be conceived as having attributes.' Now here the metaphysical doctrine enables us to conceive them as real existences, and rebuts the argument for

their inconceivability; for the other element, the material element, the feeling or quality occupying Space and Time stands in the place and performs the function of the required attributes, composing together with the space and time which is occupied the empirical phenomena of perception. So far as this argument of Mr. Spencer goes, then, we are entitled to say that his case for the inconceivability of Space and Time as real existences is not made out."

Whether the fault is in me or not I cannot say, but I fail to see that my argument is thus rebutted. On the contrary, it appears to me substantially conceded. What kind of entity is that which can exist only when occupied by something else? Dr. Hodgson's own argument is a tacit assertion that Space *by itself* cannot be conceived as an existence; and this is all that I have alleged.

Dr. Hodgson deals next with the further argument, familiar to all readers, which I have added as showing the insurmountable difficulty in the way of conceiving Space and Time as objective entities; namely, that "all entities which we actually know as such are limited. . . . But of Space and Time we cannot assert either limitation, or the absence of limitation." Without quoting at length the reasons Dr. Hodgson gives for distinguishing between Space as *per*ceived and Space as *con*ceived, it will suffice if I quote his own statement of the result to which they bring him: "So that Space and Time as perceived are not finite, but infinite, as conceived are not infinite, but finite."

Most readers will, I think, be startled by the assertion that conception is less extensive in range than perception; but, without dwelling on this, I will content myself by asking in what case Space is perceived as infinite? Surely Dr. Hodgson does not mean to say that he can perceive the whole surrounding Space at once—that the Space behind is united in perception with the Space in front. Yet this is the necessary implication of his words. Taking his statement less literally, however, and not dwelling on the fact that in perception Space is habitually bounded by objects more or less distant, let us test his

assertion under the most favourable conditions. Supposing the eye directed upwards towards a clear sky; is not the space then perceived, laterally limited? The visual area, restricted by the visual apertures, cannot include in perception even 180° from side to side, and is still more confined in a direction at right angles to this. Even in the third direction, to which alone Dr. Hodgson evidently refers, it cannot properly be said that it is infinite in perception. Look at a position in the sky a thousand miles off. Now look at a position a million miles off. What is the difference in perception? Nothing. How then can an infinite distance be perceived when these immensely-unlike finite distances cannot be perceived as differing from one another, or from an infinite distance? Dr. Hodgson has used the wrong word. Instead of saying that Space as perceived is infinite, he should have said that, in perception, Space is finite in two dimensions, and becomes *indefinite* in the third when this becomes great.

I now come to the paragraph beginning "Mr. Spencer then turns to the second or subjective hypothesis, that of Kant." This paragraph is somewhat difficult to deal with, because in it my reasoning is criticized both from the Kantian point of view and from Dr. Hodgson's own point of view. Dissenting from Kant's view, Dr. Hodgson says, "I hold that both Space and Time and Feeling, or the material element, are equally and alike subjective, equally and alike objective." As I cannot understand this, I am unable to deal with those arguments against me which Dr. Hodgson bases upon it, and must limit myself to that which he urges on behalf of Kant. He says:—

"But I think that Mr. Spencer's representation of Kant's view is very incorrect; he seems to be misled by the large term non-ego. Kant held that Space and Time were *in their origin* subjective, but when applied to the non-ego resulted in phenomena, and were the formal element in those phenomena, among which some were phenomena of the internal sense or ego, others of the external sense or non-ego. The non-ego to which the forms of Space and Time did not apply and did not belong, was the Ding-an-sich, not the

phenomenal non-ego. Hence the objective existence of Space and Time in phenomena, but not in the Ding-an-sich, is a consistent and necessary consequence of Kant's view of their subjective origin."

If I have misunderstood Kant, as thus alleged, then my comment must be that I credited him with an hypothesis less objectionable than that which he held. I supposed his view to be that Space, as a form of intuition belonging to the *ego*, is imposed by it on the *non-ego* (by which I understood the thing in itself) in the act of intuition. But now the Kantian doctrine is said to be that Space, originating in the *ego*, when applied to the *non-ego*, results in phenomena (the *non-ego* meant being, in that case, necessarily the Ding-an-sich, or thing in itself); and that the phenomena so resulting become objective existences along with the Space given to them by the subject. The subject having imposed Space as a form on the primordial object, or thing in itself, and so created phenomena, this Space thereupon becomes an objective existence, independent of both the subject and the original thing in itself! To Dr. Hodgson this may seem a more tenable position than that which I ascribed to Kant; but to me it seems only a multiplication of inconceivabilities. I am content to leave it as it stands: not feeling my reasons for rejecting the Kantian hypothesis much weakened.*

The remaining reply which Dr. Hodgson makes runs thus:—

"But Mr. Spencer has a second argument to prove this inconceivability. It is this:—'If Space and Time are forms of thought, they can never be

* Instead of describing me as misunderstanding Kant on this point, Dr. Hodgson should have described Kant as having, in successive sentences, so changed the meanings of the words he uses, as to make either interpretation possible. At the outset of his *Critique of Pure Reason*, he says:—"The effect of an object upon the faculty of representation, so far as we are affected by the said object, is sensation. That sort of intuition which relates to an object by means of sensation, is called an empirical intuition. The undetermined object of an empirical intuition, is called *phænomenon*. That which in the phænomenon corresponds to the sensation, I term its *matter*;"

thought of; since it is impossible for anything to be at once the *form* of thought and the *matter* of thought.' . . . . An instance will show the fallacy best. Syllogism is usually held to be a form of thought. Would it be any argument for the inconceivability of syllogisms to say, they cannot be at once the form and the matter of thought? Can we not syllogize about syllogism? Or, more plainly still,—no dog can bite himself, for it is impossible to be at once the thing that bites and the thing that is bitten."

Had Dr. Hodgson quoted the whole of the passage from which he takes the above sentence; or had he considered it in conjunction with the Kantian doctrine to which it refers (namely, that Space survives in consciousness when all contents are expelled, which implies that then Space is the thing with which consciousness is occupied, or the *object* of consciousness), he would have seen that his reply has none of the cogency he supposes. If, taking his first illustration, he will ask himself whether it is possible to "syllogize about syllogism," when syllogism has no content whatever, symbolic or other—has nonentity to serve for major, nonentity for minor, and nonentity for conclusion; he will, I think, see that syllogism, considered as surviving terms of every kind, cannot be syllogized about: the "pure form" of reason (supposing it to be syllogism, which it is not) if absolutely discharged of all it contains, cannot be represented in thought, and therefore cannot be reasoned about. Following Dr. Hodgson to his second illustration, I must express my surprise that a metaphysician of his acuteness should have used it. For an illustration to have any value, the relation between the terms of the analogous case

[here, remembering the definition just given of phenomenon, objective existence is manifestly referred to] "but that which effects that the content of the phænomenon can be arranged under certain relations, I call its *form*" [so that *form*, as here applied, refers to objective existence]. "But that in which our sensations are merely arranged, and by which they are susceptible of assuming a certain form, cannot be itself sensation." [In which sentence the word *form* obviously refers to subjective existence.] At the outset, the 'phenomenon' and the 'sensation' are distinguished as objective and subjective respectively; and then, in the closing sentences, the *form* is spoken of in connexion first with the one and then with the other, as though they were the same.

must have some parallelism to the relation between the terms of the case with which it is compared. Does Dr. Hodgson really think that the relation between a dog and the part of himself which he bites, is like the relation between *matter* and *form*? Suppose the dog bites his tail. Now the dog, as biting, stands, according to Dr. Hodgson, for the form as the containing mental faculty; and the tail, as bitten, stands for this mental faculty as contained. Now suppose the dog loses his tail. Can the faculty as containing and the faculty as contained be separated in the same way? Does the mental form when deprived of all content, even itself (granting that it can be its own content), continue to exist in the same way that a dog continues to exist when he has lost his tail? Even had this illustration been applicable, I should scarcely have expected Dr. Hodgson to remain satisfied with it. I should have thought he would prefer to meet my argument directly, rather than indirectly. Why has he not shown the invalidity of the reasoning used in the *Principles of Psychology* (§ 399, 2nd ed.)? Having there quoted the statement of Kant, that "Space and Time are not merely forms of sensuous intuition, but *intuitions* themselves;" I have written—

"If we inquire more closely, this irreconcilability becomes still clearer. Kant says:—'That which in the phænomenon corresponds to the sensation, I term its *matter*; but that which effects that the content of the phænomenon can be arranged under certain relations, I call its *form*.' Carrying with us this definition of form, as 'that which effects that the content . . . . can be arranged under certain relations,' let us return to the case in which the intuition of Space is the intuition which occupies consciousness. Can the content of this intuition 'be arranged under certain relations' or not? It can be so arranged, or rather, it *is* so arranged. Space cannot be thought of save as having parts, near and remote, in this direction or the other. Hence, if that is the form of a thing 'which effects that the content . . . . can be arranged under certain relations,' it follows that when the content of consciousness is the intuition of Space, which has 'parts that can be arranged under certain relations,' there must be a form of that intuition. What is it? Kant does not tell us—does not appear to perceive that there must be such a form; and could not have perceived this without abandoning his hypothesis that the space-intuition is primordial."

Now when Dr. Hodgson has shown me how that "which

effects that the content . . . . can be arranged under certain relations," may also be that which effects its own arrangement under the same relations, I shall be ready to surrender my position; but until then, no analogy drawn from the ability of a dog to bite himself will weigh much with me.

Having, as he considers, disposed of the reasons given by me for concluding that, considered in themselves, "Space and Time are wholly incomprehensible" (he continually uses on my behalf the word "inconceivable," which, by its unfit connotations, gives a wrong aspect to my position), Dr. Hodgson goes on to say:—

"Yet Mr. Spencer proceeds to use these inconceivable ideas as the basis of his philosophy. For mark, it is Space and Time as we know them, the actual and phenomenal Space and Time, to which all these inconceivabilities attach. Mr. Spencer's result, ought, therefore, logically to be—Scepticism. What is his actual result? Ontology. And how so? Why, instead of rejecting Space and Time as the inconceivable things he has tried to demonstrate them to be, he substitutes for them an Unknowable, a something which they really are, though we cannot know it, and rejects that, instead of them, from knowledge."

This statement has caused me no little astonishment. That having before him the volume from which he quotes, so competent a reader should have so completely missed the meaning of the passages (§ 26) already referred to, in which I have contended against Hamilton and Mansel, makes me almost despair of being understood by any ordinary reader. In that section I have, in the first place, contended that the consciousness of an Ultimate Reality, though not capable of being made a thought, properly so called, because not capable of being brought within limits, nevertheless remains as a consciousness that is *positive*: is not rendered *negative* by the negations of limits. I have pointed out that—

"The error, (very naturally fallen into by philosophers intent on demonstrating the limits and conditions of consciousness), consists in assuming that consciousness contains *nothing but* limits and conditions; to the entire neglect of that which is limited and conditioned. It is forgotten that there is something which alike forms the raw material of definite thought and remains after the definiteness which thinking gave to it has been destroyed"

—something which "ever persists in us as the body of a thought to which we can give no shape."

This *positive* element of consciousness it is which, "at once necessarily indefinite and necessarily indestructible," I regard as the consciousness of the Unknowable Reality. Yet Dr. Hodgson says "Mr. Spencer proceeds to use these inconceivable ideas as the basis of his philosophy:" implying that such basis consists of negations, instead of consisting of that which persists *notwithstanding the negation of limits*. And then, beyond this perversion, or almost inversion, of meaning, he conveys the notion that I take as the basis of philosophy, the "inconceivable ideas" "or self-contradictory notions" which result when we endeavour to comprehend Space and Time. He speaks of me as proposing to evolve substance out of form, or rather, out of the negations of forms—gives his readers no conception that the *Power* manifested to us is that which I regard as the Unknowable, while what we call Space and Time answer to the unknowable *nexus* of its manifestations. And yet the chapter from which I quote, and still more the chapter which follows it, makes this clear—as clear, at least, as I can make it by carefully-worded statements and re-statements.

Philosophical systems, like theological ones, following the law of evolution in general, severally become in course of time more rigid, while becoming more complex and more definite; and they similarly become less alterable—resist all compromise, and have to be replaced by the more plastic systems that descend from them.

It is thus with pure Empiricism and pure Transcendentalism. Down to the present time disciples of Locke have continued to hold that all mental phenomena are interpretable as results of accumulated individual experiences; and, by criticism, have been led simply to elaborate their interpretations—ignoring the proofs of inadequacy. On the other hand, disciples of Kant, assert-

ing this inadequacy, and led by perception of it to adopt an antagonist theory, have persisted in defending that theory under a form presenting fatal inconsistencies. And then, when there is offered a mode of reconciliation, the spirit of no-compromise is displayed: each side continuing to claim the whole truth. After it has been pointed out that all the obstacles in the way of the experiential doctrine disappear if the effects of ancestral experiences are joined with the effects of individual experiences, the old form of the doctrine is still adhered to. And meanwhile Kantists persist in asserting that the *ego* is born with intuitional forms which are wholly independent of anything in the *non-ego*, after it has been shown that the innateness of these intuitional forms may be so understood as to escape the insurmountable difficulties of the hypothesis as originally expressed.

I am led to say this by reading the remarks concerning my own views, made with an urbanity I hope to imitate, by Professor Max Müller, in a lecture delivered at the Royal Institution in March, 1873.* Before dealing with the criticisms contained in this lecture, I must enter a demurrer against that interpretation of my views by which Professor Max Müller makes it appear that they are more allied to those of Kant than to those of Locke. He says:—

"Whether the pre-historic genesis of these congenital dispositions or inherited necessities of thought, as suggested by Mr. Herbert Spencer, be right or wrong, does not signify for the purpose which Kant had in view. In admitting that there is something in our mind, which is not the result of our own *à posteriori* experience, Mr. Herbert Spencer is a thorough Kantian, and we shall see that he is a Kantian in other respects too. If it could be proved that nervous modifications, accumulated from generation to generation, could result in nervous structures that are fixed in proportion as the outer relations to which they answer are fixed, we, as followers of Kant, should only have to put in the place of Kant's intuitions of Space and Time 'the constant space-relations expressed in definite nervous structures, congenitally framed to act in definite ways, and incapable of acting in any other

* See *Fraser's Magazine* for May, 1873.

way.' If Mr. Herbert Spencer had not misunderstood the exact meaning of what Kant calls the intuitions of Space and Time, he would have perceived that, barring his theory of the pre-historic origin of these intuitions, he was quite at one with Kant."

On this passage let me remark, first, that the word "pre-historic," ordinarily employed only in respect to human history, is misleading when applied to the history of Life in general; and his use of it leaves me in some doubt whether Professor Max Müller has rightly conceived the hypothesis he refers to.

My second comment is, that the description of me as "quite at one with Kant," "*barring*" the "theory of the prehistoric origin of these intuitions," curiously implies that it is a matter of comparative indifference whether the forms of thought are held to be *naturally generated* by intercourse between the organism and its environing relations, during the evolution of the lowest into the highest types, or whether such forms are held to be *supernaturally given* to the human mind, and are independent both of environing relations and of ancestral minds. But now, addressing myself to the essential point, I must meet the statement that I have "misunderstood the exact meaning of what Kant calls the intuitions of Space and Time," by saying that I think Professor Max Müller has overlooked certain passages which justify my interpretation, and render his interpretation untenable. For Kant says "Space is *nothing else* than the form of all phenomena of the external sense;" further, he says that "Time is *nothing but* the form of our internal intuition;" and, to repeat words I have used elsewhere, "He distinctly shuts out the supposition that there are forms of the *non-ego* to which these forms of the *ego* correspond, by saying that 'Space is not a conception which has been derived from outward experiences.'" Now so far from being in harmony with, these statements are in direct contradiction to, the view which I hold; and seem to me absolutely irreconcilable with it. How can it be said that, "barring" a difference represented as trivial, I am

"quite at one with Kant," when I contend that these subjective forms of intuition are moulded into correspondence with, and therefore derived from, some objective form or *nexus*, and therefore dependent upon it; while the Kantian hypothesis is that these subjective forms are not derived from the object, but pre-exist in the subject—are imposed by the *ego* on the *non-ego*. It seems to me that not only do Kant's words, as above given, exclude the view which I hold, but also that Kant could not consistently have held any such view. Rightly recognizing, as he did, these forms of intuition as innate, he was, from his stand-point, *obliged* to regard them as imposed on the matter of intuition in the act of intuition. In the absence of the hypothesis that intelligence has been evolved, it was *not possible* for him to regard these subjective forms as having been derived from objective forms.

A disciple of Locke might, I think, say that the Evolution-view of our consciousness of Space and Time is essentially Lockian, with more truth than Professor Max Müller can represent it as essentially Kantian. The Evolution-view is completely experiential. It differs from the original view of the experientialists by containing a great extension of that view. With the relatively-small effects of individual experiences, it joins the relatively-vast effects of the experiences of antecedent individuals. But the view of Kant is avowedly and absolutely unexperiential. Surely this makes the predominance of kinship manifest.

In Professor Max Müller's replies to my criticisms on Kant, I cannot see greater validity than in this affiliation to which I have demurred. One of his arguments is that which Dr. Hodgson has used, and which I have already answered; and I think that the others, when compared with the passages of the *Principles of Psychology* which they concern, will not be found adequate. I refer to them here

chiefly for the purpose of pointing out that when he speaks of me as bringing "three arguments against Kant's view," he understates the number. Let me close what I have to say on this disputed question, by quoting the summary of reasons I have given for rejecting the Kantian hypothesis :—

"Kant tells us that Space is the form of all external intuition; which is not true. He tells us that the consciousness of Space continues when the consciousness of all things contained in it is suppressed; which is also not true. From these alleged facts he *infers* that Space is an *a priori* form of intuition. I say *infers*, because this conclusion is not presented in necessary union with the premises, in the same way that the consciousness of duality is necessarily presented along with the consciousness of inequality; but it is a conclusion voluntarily drawn for the purpose of explaining the alleged facts. And then that we may accept this conclusion, which is not necessarily presented along with these alleged facts which are not true, we are obliged to affirm several propositions which cannot be rendered into thought. When Space is itself contemplated, we have to conceive it as at once the form of intuition and the matter of intuition; which is impossible. We have to unite that which we are conscious of as Space with that which we are conscious of as the *ego*, and contemplate the one as a property of the other; which is impossible. We have at the same time to disunite that which we are conscious of as Space, from that which we are conscious of as the *non-ego*, and contemplate the one as separate from the other; which is also impossible. Further, this hypothesis that Space is "nothing else" than a form of intuition belonging wholly to the *ego*, commits us to one of the two alternatives, that the *non-ego* is formless or that its form produces absolutely no effect upon the *ego;* both of which alternatives involve us in impossibilities of thought."—*Prin. of Psy.*, § 399.

Objections of another, though allied, class have been made in a review of the *Principles of Psychology* by Mr. H. Sidgwick—a critic whose remarks on questions of mental philosophy always deserve respectful consideration.

Mr. Sidgwick's chief aim is to show what he calls "the mazy inconsistency of his [my] metaphysical results." More specifically, he expresses thus the proposition he seeks to justify—"His view of the subject appears to have a fundamental incoherence, which shows itself in various ways on the surface of his exposition, but of which the root lies

much deeper, in his inability to harmonise different lines of thought."

Before dealing with the reasons given for this judgment, let me say that, in addition to the value which candid criticisms have as showing where more explanation is needed, they are almost indispensable as revealing to a writer incongruities he had not perceived. Especially where, as in this case, the subject-matter has many aspects, and where the words supplied by our language are so inadequate in number that, to avoid cumbrous circumlocution, they have to be used in senses that vary according to the context, it is extremely difficult to avoid imperfections of statement. But while I acknowledge sundry such imperfections and the resulting incongruities, I cannot see that these are, as Mr. Sidgwick says, fundamental. Contrariwise, their superficiality seems to me proved by the fact that they may be rectified without otherwise altering the expositions in which they occur. Here is an instance.

Mr. Sidgwick points out that, when treating of the "Data of Psychology," I have said (in § 56) that, though we reach inferentially "the belief that mind and nervous action are the subjective and objective faces of the same thing, we remain utterly incapable of seeing, and even of imagining, how the two are related" (I quote the passage more fully than he does). He then goes on to show that in the "Special Synthesis," where I have sketched the evolution of Intelligence under its objective aspect, as displayed in the processes by which beings of various grades adjust themselves to surrounding actions, I "speak as if" we could see how consciousness "naturally arises at a particular stage" of nervous action. The chapter he here refers to is one describing that "differentiation of the psychical from the physical life" which accompanies advancing organization, and more especially advancing development of the nervous system. In it I have shown

that, while the changes constituting physical life continue to be characterized by the *simultaneity* with which all kinds of them go on throughout the organism, the changes constituting psychical life, arising as the nervous system develops, become gradually more distinguished by their *seriality*. And I have said that as nervous integration advances, "there must result an unbroken series of these changes—there must arise a consciousness." Now I admit that here is an apparent inconsistency. I ought to have said that "there must result an unbroken series of these changes," which, taking place in the nervous system of a highly-organized creature, gives coherence to its conduct; and along with which we assume a consciousness, because consciousness goes along with coherent conduct in ourselves. If Mr. Sidgwick will substitute this statement for the statement as it stands, he will see that the arguments and conclusions remain intact. A survey of the chapter as a whole, proves that its aim is not in the least to explain how nervous changes, considered as waves of molecular motion, become the feelings constituting consciousness; but that, contemplating the facts objectively in living creatures at large, it points out the cardinal distinction between vital actions in general, and those particular vital actions which, in a creature displaying them, lead us to speak of it as intelligent. It is shown that the rise of such actions becomes marked in proportion as the changes taking place in the part called the nervous system, are made more and more distinctly serial, by union in a supreme centre of co-ordination. The introduction of the word consciousness, arises in the effort to show what fundamental character there is in these particular physiological changes which is *parallel to* a fundamental character in the psychological changes.

Another instance of the way in which Mr. Sidgwick evolves an incongruity which he considers fundamental, out of what I should have thought he would see is a

defective expression, I will give in his own words. Speaking of a certain view of mine, he says:—

"He tells us that 'logic . . . contemplates in its propositions certain connexions predicated, which are necessarily involved with certain other connexions given: *regarding all these connexions as existing in the non-ego*—not, it may be, under the form in which we know them, but in some form.' But in § 478, where Mr. Spencer illustrates by a diagram his 'Transfigured Realism,' the view seems to be this: although we cannot say that the real non-ego resembles our notion of it in 'its elements, relations, or laws,' we can say that 'a change in the objective reality causes in the subjective state a change exactly answering to it—so answering as to *constitute a cognition of it*.' Here the 'something beyond consciousness' is no longer said to be unknown, as its effect in consciousness 'constitutes a cognition of it.'"

This apparent inconsistency, marked by the italics, would not have existed if, instead of "a cognition of it," I had said, as I ought to have said, "*what we call* a cognition of it"—that is, a relative cognition as distinguished from an absolute cognition. In ordinary language we speak of as cognitions, those connexions in thought which so guide us in our dealings with things, that actual experience verifies ideal anticipation: marking off, by opposed words, those connexions in thought which *mis*-guide us. The difference between accepting a cognition as relatively true and accepting it as absolutely true, will be clearly shown by an illustration. There is no direct resemblance whatever between the sizes, forms, colours, and arrangements, of the figures in an account-book, and the moneys or goods, debts or credits, represented by them; and yet the forms and arrangements of the written symbols, are such as answer in a perfectly-exact way to stocks of various commodities and to various kinds of transactions. Hence we say, figuratively, that the account-book will "tell us" all about these stocks and transactions. Similarly, the diagram Mr. Sidgwick refers to, suggests a way in which symbols, registered in us by objects, may have forms and arrangements wholly unlike their objective causes and the *nexus* among those causes, while yet they are so related as to guide us correctly in our transactions

with those objective causes, and, *in that sense*, constitute cognitions of them; though they no more constitute cognitions in the absolute sense, than do the guiding symbols in the account-book constitute cognitions of the things to which they refer. So repeatedly is this view implied throughout the *Principles of Psychology*, that I am surprised to find a laxity of expression raising the suspicion that I entertain any other.

To follow Mr. Sidgwick through sundry criticisms of like kind, which may be similarly met, would take more space than I can here afford. I must restrict myself now to the alleged "fundamental incoherence" of which he thinks these inconsistencies are signs. I refer to that reconciliation of Realism and Idealism considered by him as an impossible compromise. A difficulty is habitually felt in accepting a coalition after long conflict. Whoever has espoused one of two antagonist views, and, in defending it, has gained a certain comprehension of the opposite view, becomes accustomed to regard these as the only alternatives, and is puzzled by an hypothesis which is at once both and neither. Yet, since it turns out in nearly all cases that, of conflicting doctrines, each contains an element of truth, and that controversy ends by combination of their respective half-truths, there is *a priori* probability on the side of an hypothesis which qualifies Realism by Idealism.

Mr. Sidgwick expresses his astonishment, or rather bespeaks that of his readers, because, while I accept Idealistic criticisms, I nevertheless defend the fundamental intuition of Common Sense; and, as he puts it, "fires his [my] argument full in the face of Kant, Mill, and 'metaphysicians' generally."

"He tells us that 'metaphysicians' illegitimately assume that 'beliefs reached through complex intellectual processes,' are more valid than 'beliefs reached through simple intellectual processes;' that the common language they use refuses to express their hypotheses, and thus their reasoning inevitably implies the common notions which they repudiate; that the belief of Realism has the advantage of 'priority,' 'simplicity,' 'distinctness.'

But surely this prior, simple, distinctly affirmed belief is that of what Mr. Spencer terms 'crude Realism', the belief that the non-ego is *per se* extended, solid, even coloured (if not resonant and odorous). This is what common language implies; and the argument by which Mr. Spencer proves the relativity of feelings and relations, still more the subtle and complicated analysis by which he resolves our notion of extension into an aggregate of feelings and transitions of feeling, lead us away from our original simple belief—that (*e.g.*) the green grass we see exists out of consciousness as we see it—just as much as the reasonings of Idealism, Scepticism, or Kantism."

On the face of it the anomaly seems great; but I should have thought that after reading the chapter on "Transfigured Realism," a critic of Mr. Sidgwick's acuteness would have seen the solution of it. He has overlooked an essential distinction. All which my argument implies is that the direct intuition of Realism must be held of superior authority to the arguments of Anti-Realism, *where their deliverances cannot be reconciled.* The one point on which their deliverances cannot be reconciled, is the existence of an objective reality. But while, against this intuition of Realism, I hold the arguments of Anti-Realism to be powerless, because they cannot be carried on without postulating that which they end by denying; yet, having admitted objective existence as a necessary postulate, it is possible to make valid criticisms upon all those judgments which Crude Realism joins with this primordial judgment: it is possible to show that a transfigured interpretation of properties and relations, is more tenable than the original interpretation.

To elucidate the matter, let us take the most familiar case in which the indirect judgments of Reason correct the direct judgments of Common Sense. The direct judgment of Common Sense is that the Sun moves round the Earth. In course of time, Reason, finding some facts at variance with this, begins to doubt; and, eventually, hits upon an hypothesis which explains the anomalies, but which denies this apparently-certain *dictum* of Common Sense. What is the reconciliation? It consists in showing

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to Common Sense that the new interpretation equally well corresponds with direct intuition, while it avoids all the difficulties. Common Sense is reminded that the apparent motion of an object may be due either to its actual motion or to the motion of the observer; and that there are terrestrial experiences in which the observer thinks an object he looks at is moving, when the motion is in himself. Extending the conception thus given, Reason shows that if the Earth revolves on its axis, there will result that apparent motion of the Sun which Common Sense interpreted into an actual motion of the Sun; and the common-sense observer thereupon becomes able to think of sunrise and sunset as due to his position as spectator on a vast revolving globe. Now if the astronomer, setting out by recognizing these celestial appearances, and proceeding to evolve the various anomalies following from the common-sense interpretation of them, had drawn the conclusion that there externally exist no Sun and no motion at all, he would have done what Idealists do; and his arguments would have been equally powerless against the intuition of Common Sense. But he does nothing of the kind. He accepts the intuition of Common Sense respecting the reality of the Sun and of the motion; but replaces the old interpretation of the motion by a new interpretation reconcilable with all the facts.

Everyone must see that here, acceptance of the inexpugnable element in the common-sense judgment, by no means involves acceptance of the accompanying judgments; and I contend that the like discrimination must be made in the case we are considering. It does not follow that while, against the consciousness which Crude Realism has of an objective reality, the arguments of Anti-Realism are futile, they are therefore futile against the conceptions which Crude Realism forms of the objective reality. If Anti-Realism can show that, granting an objective reality, the interpretation of Crude Realism contains insuperable

difficulties, the process is quite legitimate. And, its primordial intuition remaining unshaken, Realism may, on reconsideration, be enabled to frame a new conception which harmonizes all the facts.

To show that there is not here the "mazy inconsistency" alleged, let us take the case of sound as interpreted by Crude Realism, and as re-interpreted by Transfigured Realism. Crude Realism assumes the sound present in consciousness to exist as such beyond consciousness. Anti-Realism proves the inadmissibility of this assumption in sundry ways (all of which, however, set out by talking of sounding bodies beyond consciousness, just as Realism talks of them); and then Anti-Realism concludes that we know of no existence save the sound as a mode of consciousness: which conclusion, and all kindred conclusions, I contend are vicious—first, because all the words used connote an objective activity; second, because the arguments are impossible without postulating at the outset an objective activity; and third, because no one of the intuitions out of which the arguments are built, is of equal validity with the single intuition of Realism that an objective activity exists. But now the Transfigured Realism which Mr. Sidgwick thinks "has all the serious incongruity of an intense metaphysical dream," neither affirms the untenable conception of Crude Realism, nor, like Anti-Realism, draws unthinkable conclusions by suicidal arguments; but, accepting that which is essential in Crude Realism, and admitting the difficulties which Anti-Realism insists upon, reconciles matters by a re-interpretation analogous to that which an astronomer makes of the solar motion. Continuing all along to recognize an objective activity which Crude Realism calls sound, it shows that the answering sensation is produced by a succession of separate impacts which, if made slowly, may be separately identified, and which will, if progressively increased in rapidity, produce tones higher and higher in pitch. It

shows by other experiments that sounding bodies are in states of vibration, and that the vibrations may be made visible. And it concludes that the objective activity is not what it subjectively seems, but is proximately interpretable as a succession of aërial waves. Thus Crude Realism is shown that while there unquestionably exists an objective activity corresponding to the sensation known as sound, yet the facts are not explicable on the original supposition that this is like the sensation; while they are explicable by conceiving it as a rhythmical mechanical action. Eventually this re-interpretation, joined with kindred re-interpretations of other sensations, comes to be itself further transfigured by analysis of its terms, and re-expression of them in terms of molecular motion; but, however abstract the interpretation ultimately reached, the objective activity continues to be postulated: the primordial judgment of Crude Realism remains unchanged, though it has to change the rest of its judgments.

In another part of his argument, however, Mr. Sidgwick implies that I have no right to use those conceptions of objective existence by which this compromise is effected. Quoting sundry passages to show that while I hold the criticisms of the Idealist to be impossible without "tacitly or avowedly postulating an unknown something beyond consciousness," I yet admit that "our states of consciousness are the only things we can know;" he goes on to argue that I am radically inconsistent, because, in interpreting the phenomena of consciousness, I continually postulate, not an unknown something, but a something of which I speak in ordinary terms, as though its ascribed physical characters really exist as such, instead of being, as I admit they are, synthetic states of my consciousness. His objection, if I understand it, is that for the purposes of Objective Psychology I apparently profess to know Matter and Motion in the ordinary realistic way; while, as a result of subjective analysis, I reach the conclusion that

it is impossible to have that knowledge of objective existence which Realism supposes we have. Doubtless there seems here to be what he calls "a fundamental incoherence." But I think it exists, not between my two expositions, but between the two consciousnesses of subjective and objective existence, which we cannot suppress and yet cannot put into definite forms. The alleged incoherence I take to be but another name for the inscrutability of the relation between subjective feeling and its objective correlate which is not feeling—an inscrutability which meets us at the bottom of all our analyses. An exposition of this inscrutability I have elsewhere summed up thus:—

"See, then, our predicament. We can think of Matter only in terms of Mind. We can think of Mind only in terms of Matter. When we have pushed our explorations of the first to the uttermost limit, we are referred to the second for a final answer; and when we have got the final answer of the second, we are referred back to the first for an interpretation of it. We find the value of x in terms of y; then we find the value of y in terms of x; and so on we may continue for ever without coming nearer to a solution."—*Prin. of Psy.* § 272.

Carrying a little further this simile, will, I think, show where lies the insuperable difficulty felt by Mr. Sidgwick. Taking x and y as the subjective and objective activities, unknown in their natures and known only as phenomenally manifested; and recognizing the fact that every state of consciousness implies, immediately or remotely, the action of object on subject or subject on object, or both; we may say that every state of consciousness will be symbolized by some modification of xy—the phenomenally-known product of the two unknown factors. In other words, xy', $x'y$, $x'y'$, $x''y'$, $x'y''$, &c., &c., will represent all perceptions and thoughts. Suppose, now, that these are thoughts about the object; composing some hypothesis respecting its characters as analyzed by physicists. Clearly, all such thoughts, be they about shapes, resistances, momenta, molecules, molecular motions, or what not, will contain forms of the subjective activity x. Now let the thoughts

be concerning mental processes. It must similarly happen that some mode of the unknown objective activity y, will be in every case a component. Now suppose that the problem is the genesis of mental phenomena; and that, in the course of the inquiry, bodily organization and the functions of the nervous system are brought into the explanation. It will happen, as before, that these, considered as objective, have to be described and thought about in modes of xy. And when by the actions of such a nervous system, conceived objectively in modes of xy, and acted upon by physical forces which are conceived in other modes of xy, we endeavour to explain the genesis of sensations, perceptions, and ideas, which we can think of only in other modes of xy, we find that all our factors, and therefore all our interpretations, contain the two unknown terms, and that no interpretation is imaginable that will not contain the two unknown terms.

What is the defence for this apparently-circular process? Simply that it is a process of establishing *congruity* among our symbols. It is finding a mode of so symbolizing the unknown activities, subjective and objective, and so operating with our symbols, that all our acts may be rightly guided—guided, that is, in such ways that we can anticipate, when, where, and in what quantity some one of our symbols, or some combination of our symbols, will be found. Mr. Sidgwick's difficulty arises, I think, from having insufficiently borne in mind the statements made at the outset, in "The Data of Philosophy," that such conceptions as "are vital, or cannot be separated from the rest without mental dissolution, must be assumed as true *provisionally*;" that "there is no mode of establishing the validity of any belief except that of showing its entire *congruity* with all other beliefs;" and that "Philosophy, compelled to make those fundamental assumptions without which thought is impossible, has to justify them by showing their *congruity* with all other dicta of consciousness." In

pursuance of this distinctly-avowed mode of procedure, I assume provisionally, an objective activity and a subjective activity, and certain general forms and modes (Space, Time, Matter, Motion, Force), which the subjective activity, operated on by the objective activity, ascribes to it, and which I suppose to correspond in some way to unknown forms and modes of the objective activity. These provisional assumptions, having been carried out to all their consequences, and these consequences proved to be congruous with one another and with the original assumptions, these original assumptions are justified. And if, finally, I assert, as I have repeatedly asserted, that the terms in which I express my assumptions and carry on my operations are but symbolic, and that all I have done is to show that by certain ways of symbolizing, perfect harmony results—invariable agreement between the symbols in which I frame my expectations, and the symbols which occur in experience—I cannot be blamed for incoherence. On the contrary, it seems to me that my method is the most coherent that can be devised. Lastly, should it be said that this regarding of everything constituting experience and thought as symbolic, has a very shadowy aspect; I reply that these which I speak of as symbols, are real relatively to our consciousness; and are symbolic only in their relation to the Ultimate Reality.

That these explanations will make clear the coherence of views which before seemed "fundamentally incoherent," I feel by no means certain; since, as I did not perceive the difficulties presented by the exposition as at first made, I may similarly fail to perceive the difficulties in this explanation. Originally, I had intended to complete the *Principles of Psychology* by a division showing how the results reached in the preceding divisions, physiological and psychological, analytic and synthetic, subjective and objective, harmonize with one another, and are but different aspects of the same aggregate of phenomena. But the work was already

bulky; and I concluded that this division might be dispensed with, because the congruities to be pointed out were sufficiently obvious. So little was I conscious of the alleged "inability to harmonize different lines of thought." Mr. Sidgwick's perplexities, however, show me that such an exposition of concords is needful.

I have reserved to the last, one of the first objections made to the metaphysico-theological doctrine set forth in *First Principles*, and implied in the several volumes that have succeeded it. It was urged by an able metaphysician, the Rev. James Martineau, in an essay entitled "Science, Nescience, and Faith;" and, effective against my argument as it stands, shows the need for some development of my argument. That Mr. Martineau's criticism may be understood, I must quote the passages it concerns. Continuing the reasoning employed against Hamilton and Mansel, to show that our consciousness of that which transcends knowledge is *positive*, and not, as they allege, *negative*, I have said:—

"Still more manifest will this truth become when it is observed that our conception of the Relative itself disappears, if our conception of the Absolute is a pure negation. It is admitted, or rather it is contended, by the writers I have quoted above, that contradictories can be known only in relation to each other—that Equality, for instance, is unthinkable apart from its correlative Inequality; and that thus the Relative can itself be conceived only by opposition to the Non-relative. It is also admitted, or rather contended, that the consciousness of a relation implies a consciousness of both the related members. If we are required to conceive the relation between the Relative and Non-relative without being conscious of both, 'we are in fact' (to quote the words of Mr. Mansel differently applied) 'required to compare that of which we are conscious with that of which we are not conscious; the comparison itself being an act of consciousness, and only possible through the consciousness of both its objects.' What, then, becomes of the assertion that, 'the Absolute is conceived merely by a negation of conceivability,' or as 'the mere absence of the conditions under which consciousness is possible?' If the Non-relative or Absolute, is present in thought only as a mere negation, then the relation between it and the Relative becomes unthinkable, because one of the terms of the relation is absent from consciousness.

And if this relation is unthinkable, then is the Relative itself unthinkable, for want of its antithesis: whence results the disappearance of all thought whatever."—*First Principles*, § 26.

On this argument Mr. Martineau comments as follows; first re-stating it in other words:—

"Take away its antithetic term, and the relative, thrown into isolation, is set up as absolute, and disappears from thought. It is indispensable therefore to uphold the Absolute in existence, as condition of the relative sphere which constitutes our whole intellectual domain. Be it so: but when saved on this plea,—to preserve the balance and interdependence of two *co*-relatives,—the 'Absolute' is absolute no more; it is reduced to a term of relation: it loses therefore its exile from thought: its disqualification is cancelled: and the alleged nescience is discharged.

"So, the same law of thought which warrants the existence, dissolves the inscrutableness, of the Absolute."—*Essays, Philosophical and Theological* pp. 186-7.

I admit this to be a telling rejoinder; and one which can be met only when the meanings of the words, as I have used them, are carefully discriminated, and the implications of the doctrine fully traced out. We will begin by clearing the ground of minor misconceptions.

First, let it be observed that though I have used the word Absolute as the equivalent of Non-relative, because it is used in the passages quoted from the writers I am contending against; yet I have myself chosen for the purposes of my argument, the name Non-relative, and I do not necessarily commit myself to any propositions respecting the Absolute, considered as that which includes both Subject and Object. The Non-relative as spoken of by me, is to be understood rather as the totality of Being *minus* that which constitutes the individual consciousness, present to us under forms of Relation. Did I use the word in some Hegelian sense, as comprehensive of that which thinks and that which is thought about, and did I propose to treat of the order of things, not as phenomenally manifested but as noumenally proceeding, the objection would be fatal. But the aim being simply to formulate the order of things as present under relative forms, the antithetical Non-relative here named as

implied by the conception of the Relative, is that which, in any act of thought, is outside of and beyond it, rather than that which is inclusive of it. Further, it should be observed that this Non-relative, spoken of as a necessary complement to the Relative, is not spoken of as a conception but as a *consciousness*, and I have in sundry passages distinguished between those modes of consciousness which, having limits, and constituting thought proper, are subject to the laws of thought, and the mode of consciousness which persists when the removal of limits is carried to the uttermost, and when distinct thought consequently ceases.

This opens the way to the reply here to be made to Mr. Martineau's criticism—namely, that while by the necessities of thought the Relative implies a Non-relative; and while, to think of this antithesis completely, requires that the Non-relative shall be made a conception proper; yet, for the vague thought which is alone in this case possible, it suffices that the Non-relative shall be present as a consciousness which though undefined is positive. Let us observe what necessarily happens when thought is employed on this ultimate question.

In a preceding part of the argument criticized, I have, in various ways, aimed to show that, alike when we analyze the product of thought and when we analyze the process of thought, we are brought to the conclusion that invariably "a thought involves *relation, difference, likeness;*" and that even from the very nature of Life itself, we may evolve the conclusion that "thinking being relationing, no thought can ever express more than relations." What, now, must happen if thought, having this law, occupies itself with the final mystery? Always implying terms in relation, thought implies that both terms shall be more or less defined; and as fast as one of them becomes indefinite, the relation also becomes indefinite, and thought becomes indistinct. Take the

case of magnitudes. I think of an inch; I think of a foot; and having tolerably-definite ideas of the two, I have a tolerably-definite idea of the relation between them. I substitute for the foot a mile; and being able to represent a mile much less definitely, I cannot so definitely think of the relation between an inch and a mile—cannot distinguish it in thought from the relation between an inch and two miles, as clearly as I can distinguish in thought the relation between an inch and one foot from the relation between an inch and two feet. And now if I endeavour to think of the relation between an inch and the 240,000 miles from here to the Moon, or the relation between an inch and the 93,000,000 miles from here to the Sun, I find that while these distances, practically inconceivable, have become little more than numbers to which I frame no answering ideas, so, too, has the relation between an inch and either of them become practically inconceivable. Evidently then this partial failure in the process of forming thought-relations, which happens even with finite magnitudes when one of them is immense, passes into complete failure when one of them cannot be brought within any limits. The relation itself becomes unrepresentable at the same time that one of its terms becomes unrepresentable. Nevertheless, in this case it is to be observed that the almost-blank form of relation preserves a certain qualitative character. It is still distinguishable as belonging to the consciousness of extensions, not to the consciousnesses of forces or durations; and in so far remains a vaguely-identifiable relation. But now suppose we ask what happens when one term of the relation has not simply magnitude having no known limits, and duration of which neither beginning nor end is cognizable, but is also an existence not to be defined? In other words, what must happen if one term of the relation is not only quantitatively but also qualitatively unrepresentable? Clearly in this case the

relation does not simply cease to be thinkable except as a relation of a certain class, but it lapses completely. When one of the terms becomes wholly unknowable, the law of thought can no longer be conformed to; both because one term cannot be present, and because relation itself cannot be framed. That is to say, the law of thought that contradictories can be known only in relation to each other, no longer holds when thought attempts to transcend the Relative; and yet, when it attempts to transcend the Relative, it must make the attempt in conformity with its law—must in some dim mode of consciousness posit a Non-relative, and, in some similarly dim mode of consciousness, a relation between it and the Relative. In brief then, to Mr. Martineau's objection I reply, that the insoluble difficulties he indicates arise here, as elsewhere, when thought is applied to that which transcends the sphere of thought; and that just as when we try to pass beyond phenomenal manifestations to the Ultimate Reality manifested, we have to symbolize it out of such materials as the phenomenal manifestations give us; so we have simultaneously to symbolize the connexion between this Ultimate Reality and its manifestations, as somehow allied to the connexions among the phenomenal manifestations themselves. The truth Mr. Martineau's criticism adumbrates, is that the law of thought fails where the elements of thought fail; and this is a conclusion quite conformable to the general view I defend. Still holding the validity of my argument against Hamilton and Mansel, that in pursuance of their own principle the Relative is not at all thinkable *as such*, unless in contradistinction to some existence posited, however vaguely, as the other term of a relation, conceived however indefinitely; it is consistent on my part to hold that in this effort which thought inevitably makes to pass beyond its sphere, not only does the product of thought become a dim symbol of a product, but the process of thought becomes a dim

symbol of a process; and hence any predicament inferable from the law of thought cannot be asserted.

I may fitly close this reply by a counter-criticism. To the direct defence of a proposition, may be added the indirect defence which results from showing the untenability of an alternative proposition. This criticism on the doctrine of an Unknowable Existence manifested to us in phenomena, Mr. Martineau makes in the interests of the doctrine held by him, that this existence is, to a considerable degree, knowable. We are quite at one in holding that there is an indestructible consciousness of Power behind Appearance; but whereas I contend that this Power cannot be brought within the forms of thought, Mr. Martineau contends that there can be consistently ascribed certain attributes of personality—not, indeed, human characteristics so concrete as were ascribed in past times; but still, human characteristics of the more abstract and higher class. His general doctrine is this:—Regarding Matter as independently existing; regarding as also independently existing, those primary qualities of Body "which are inseparable from the very idea of Body, and may be evolved *a priori* from the consideration of it as solid extension or extended solidity;" and saying that to this class "belong Triple Dimension, Divisibility, Incompressibility;" he goes on to assert that as these—

"cannot absent themselves from Body, they have a reality coeval with it, and belong eternally to the material datum objective to God: and his mode of activity with regard to them must be similar to that which alone we can think of his directing upon the relations of Space, viz. not Volitional, to cause them, but Intellectual, to think them out. The Secondary Qualities, on the other hand, having no logical tie to the Primary, but being appended to them as contingent facts, cannot be referred to any deductive thought, but remain over as products of pure Inventive Reason and Determining Will. This sphere of cognition, *a posteriori* to us,—where we cannot move a step alone but have submissively to wait upon experience, is precisely the realm of Divine originality: and we are most sequacious where He is most free. While on this Secondary field His Mind and ours are thus contrasted, they meet in resemblance again upon the Primary: for the evolutions of deductive Reason there is but one track possible to all intelligences; no *merum*

arbitrium can interchange the false and true, or make more than one geometry, one scheme of pure Physics, for all worlds: and the Omnipotent Architect Himself, in realizing the Kosmical conception, in shaping the orbits out of immensity and determining seasons out of eternity, could but follow the laws of curvature, measure, and proportion."—*Essays, Philosophical and Theological*, pp. 163-4.

Before the major criticism which I propose to make on this hypothesis, let me make a minor one. Not only of space-relations, but also of primary physical properties, Mr. Martineau asserts the necessity: not a necessity to our minds simply, but an ontological necessity. What is true for human thought, is, in respect of these, true absolutely: "the laws of curvature, measure, and proportion," as we know them, are unchangeable even by Divine power; as are also the Divisibility and Incompressibility of Matter. But if, in these cases, Mr. Martineau holds that a necessity in thought implies an answering necessity in things, why does he refrain from saying the like in other cases? Why, if he tacitly asserts it in respect of space-relations and the statical attributes of Body, does he not also assert it in respect of the dynamical attributes of Body? The laws conformed to by that mode of force now distinguished as "energy," are as much necessary to our thought as are the laws of space-relations. The axioms of Mechanics lie on the same plane with the axioms of pure Mathematics. Now if Mr. Martineau admits this—if he admits, as he must, the corollary that there can be no such manifestation of energy as that displayed in the motion of a planet, save at the expense of equivalent energy which pre-existed—if he draws the further necessary corollary that the direction of a motion cannot be changed by any action, without an equal reaction in an opposite direction on something acting—if he bears in mind that this holds not only of all visible motions, celestial and terrestrial, but that those activities of Body which affect us as secondary properties, are also known only through other forms of

energy, which are equivalents of mechanical energy and conform to these same laws—and if, lastly, he infers that none of these derivative energies can have given to them their characters and directions, save by pre-existing forces, statical and dynamical, conditioned in special ways; what becomes of that "realm of Divine originality" which Mr. Martineau describes as remaining within the realm of necessity? Consistently carried out, his argument implies a universally-inevitable order, in which volition can have no such place as that he alleges.

Not pushing Mr. Martineau's reasoning to this conclusion, so entirely at variance with the one he draws, but accepting his statement just as it stands, let us consider the solution it offers us. We are left by it without any explanation of Space and Time; we are not helped in conceiving the origin of Matter; and there is afforded us no idea how Matter came to have its primary attributes. All these are tacitly assumed to exist uncreated. Creative activity is represented as under the restrictions imposed by mathematical necessities, and as having for *datum* (mark the word) a substance which, in respect of certain characters, defies modification. But surely this is not an interpretation of the mystery of things. The mystery is simply relegated to a remoter region, respecting which no inquiry is to be made. But the inquiry *must* be made. After every such solution there arises afresh the question—what is the origin and nature of that which imposes these limits on creative power? what is the primary God which dominates over this secondary God? For, clearly, if the "Omnipotent Architect himself" (to use Mr. Martineau's somewhat inconsistent name) is powerless to change the "material datum objective" to him, and powerless to change the conditions under which it exists, and under which he works, there is obviously implied a power to which he is subject. So that in Mr. Martineau's doctrine also, there is an Ultimate

Unknowable; and it differs from the doctrine he opposes, only by intercalating a partially Knowable between this and the wholly Knowable.

Finding, as explained above, that this interpretation is not consistent with itself; and finding, as just shown, that it leaves the essential mystery unsolved; I do not see that it has an advantage over the doctrine of the Unknowable in its unqualified shape. There cannot, I think, be more than temporary rest in a proximate solution which takes for its basis the ultimately insoluble. Just as thought cannot be prevented from passing beyond Appearance, and trying to conceive the Cause behind; so, following out the interpretation Mr. Martineau offers, thought cannot be prevented from asking what Cause it is which restricts the Cause he assigns. And if we must admit that the question under this eventual form cannot be answered, may we not as well confess that the question under its immediate form cannot be answered? Is it not better candidly to acknowledge the incompetence of our intelligence, rather than to persist in calling that an explanation which does but disguise the inexplicable? Whatever answer each may give to this question, he cannot rightly blame those who, finding in themselves an indestructible consciousness of an ultimate Cause, whence proceed alike what we call the Material Universe and what we call Mind, refrain from affirming anything respecting it; because they find it as inscrutable in nature as it is inconceivable in extent and duration.

Postscript.—With the concluding paragraph of the foregoing article, I had hoped to end, for a long time, all controversial writing; and, if the article had been published entire in the November number of the *Fortnightly*, as originally intended, the need for any addition would not have been pressing. But while it was in the printer's

hands, two criticisms, more elaborate than those dealt with above, made their appearance; and now that the postponed publication of this latter half of the article affords the opportunity, I cannot, without risking misinterpretations, leave these criticisms unnoticed.

Especially do I feel called upon by courtesy to make some response to one who, in the *Quarterly Review* for October, 1873, has dealt with me in a spirit which, though largely antagonistic, is not wholly unsympathetic; and who manifestly aims to estimate justly the views he opposes. In the space at my disposal, I cannot of course follow him through all the objections he has urged. I must content myself with brief comments on the two propositions he undertakes to establish. His enunciation of these runs thus :—

"We would especially direct attention to two points, to both of which we are confident objections may be made; and although Mr. Spencer has himself doubtless considered such objections (and they may well have struck many of his readers also), we nevertheless do not observe that he has anywhere noticed or provided for them.

"The two points we so select are:—

"(1) *That his system involves the denial of all truth.*

"(2) *That it is radically and necessarily opposed to all sound principles of morals.*"

On this passage, ending in these two startling assertions, let me first remark that I am wholly without this consciousness the reviewer ascribes to me. Remembering that I have expended some little labour in developing what I conceive to be a system of truths, I am surprised by the supposition that "the denial of all truth" is an implication which I am "doubtless" aware may be alleged against this system. Remembering, too, that by its programme this system is shown to close with two volumes on *The Principles of Morality*, the statement that it is "necessarily opposed to all sound principles of morals," naturally astonishes me; and still more the statement that I am doubtless conscious it may be so regarded. Saying thus much by way of repudiating that latent scepticism

attributed to me by the reviewer, I proceed to consider what he says in proof of these propositions.

On those seeming incongruities of Transfigured Realism commented on by him, I need say no more than I have already said in reply to Mr. Sidgwick; by whom also they have been alleged. I will limit myself to the corollary he draws from the doctrine of the Relativity of Knowledge, as held by me. Rightly pointing out that I hold this in common with "Messrs. Mill, Lewes, Bain, and Huxley;" but not adding, as he should have done, that I hold it in common with Hamilton, Mansel, and the long list of predecessors through whom Hamilton traced it; the reviewer proceeds to infer from this doctrine of relativity that no absolute truth of any kind can be asserted—not even the absolute truth of the doctrine of relativity itself. And then he leaves it to be supposed by his readers, that this inference tells especially against the system he is criticizing. If, however, the reviewer's inference is valid, this "denial of all truth" must be charged against the doctrines of thinkers called orthodox, as well as against the doctrines of those many philosophers, from Aristotle down to Kant, who have said the same thing. But now I go further, and reply that against that form of the doctrine of relativity held by me, this allegation cannot be made with the same effect as it can against preceding forms of the doctrine. For I diverge from other relativists in asserting that the existence of a non-relative is not only a positive deliverance of consciousness, but a deliverance transcending in certainty all others whatever; and is one without which the doctrine of relativity cannot be framed in thought. I have urged that "unless a real Non-relative or Absolute be postulated, the Relative itself becomes absolute; and so brings the argument to a contradiction;"* and elsewhere I have described this consciousness of a Non-relative manifested to us through the Relative as

* *First Principles*, § 26.

"deeper than demonstration—deeper even than definite cognition—deep as the very nature of mind;"* which seems to me to be saying as emphatically as possible that, while all other truths may be held as relative, this truth must be held as absolute. Yet, strangely enough, though contending thus against the pure relativists, and holding with the reviewer, that "every asserter of such a [purely-relative] philosophy must be in the position of a man who saws across the branch of a tree on which he actually sits, at a point between himself and the trunk,"† I am singled out by him as though this were my own predicament! So far, then, from admitting that the view I hold "involves the denial of all truth," I assert that, having at the outset posited the co-existence of subject and object as a deliverance of consciousness which precedes all reasoning;‡ having subsequently shown, analytically, that this postulate is in every way verified,§ and that in its absence the proof of relativity is impossible; my view is distinguished by an exactly-opposite trait.

The justification of his second proposition the reviewer commences by saying that—"In the first place the process of Evolution, as understood by Mr. Spencer, compels him to be at one with Mr. Darwin in his denial of the existence of any fundamental and essential distinction between Duty and Pleasure." Following this by a statement respecting the genesis of moral sentiments as understood by me (which is extremely unlike the one I have given in the *Principles of Psychology*, § 215, §§ 503-512, and §§ 524-532), the reviewer goes on to say that "We yield with much reluctance to the necessity of affirming that Mr. Spencer gives no evidence of ever having acquired a knowledge of the meaning of the term 'morality,' according to the true sense of the word."

Just noting that, as shown by the context, the assertion

* *Ibid.* § 76 (1st ed.) † Compare *Principles of Psychology*, §§ 88, 95, 391, 401, 406
‡ *First Principles*, §§ 39-45. § *Principles of Psychology*, part vii.

thus made is made against all those who hold the Doctrine of Evolution in its unqualified form, I reply that in so far as it concerns me, it is one the reviewer would scarcely have made had he more carefully examined the evidence: not limiting himself to those works of mine named at the head of his article. And I cannot but think that had the spirit of fairness which he evidently strives to maintain, been fully awake when these passages were written, he would have seen that, before making so serious an allegation, wider inquiry was needful. If he had simply said that, given the doctrine of mental evolution as held by me, he failed to see how moral principles are to be established, I should not have objected; provided he had also said that I believe they can be established, and had pointed out what I hold to be their bases. As it is, however, he has so presented his own inference from my premises, as to make it seem an inference which I also must draw from my premises. Quite a different and much more secure foundation for moral principles is alleged by me, than that afforded by moral sentiments and conceptions; which he refers to as though they formed the sole basis of the ethical conclusions I hold. While the reviewer contends that "Mr. Spencer's moral system is even yet more profoundly defective, as it denies any objective distinction between right and wrong in any being, whether men are or are not responsible for their actions;" I contend, contrariwise, that it is distinguished from other moral systems by asserting the objectivity of the distinction, and by endeavouring to show that the subjective distinction is derived from the objective distinction. In my first work, *Social Statics*, published twenty-three years ago, the essential thesis is that, apart from their warrant as alleged Divine injunctions, and apart from their authority as moral intuitions, the principles of justice are primarily deducible from the laws of life as carried on under social conditions. I argued throughout that these principles so derived have

a supreme authority, to which considerations of immediate expediency must yield; and I was for this reason classed by Mr. Mill as an anti-utilitarian. More recently, in a letter drawn from me by this misapprehension of Mr. Mill, and afterwards published by Professor Bain in his *Mental and Moral Science*, I have re-stated this position. Already, in an explanatory article entitled *Morals and Moral Sentiments*, published in the *Fortnightly Review* for April, 1871, I have quoted passages from that letter; and here, considering the gravity of the assertions made by the *Quarterly* reviewer, I hope to be excused for re-quoting them:—

"Morality, properly so called—the science of right conduct—has for its object to determine *how* and *why* certain modes of conduct are detrimental, and certain other modes beneficial. These good and bad results cannot be accidental, but must be necessary consequences of the constitution of things; and I conceive it to be the business of Moral Science to deduce from the laws of life and the conditions of existence, what kinds of action necessarily tend to produce happiness, and what kinds to produce unhappiness. Having done this, its deductions are to be recognized as laws of conduct; and are to be conformed to irrespective of a direct estimation of happiness or misery."

* * * * * *

"If it is true that pure rectitude prescribes a system of things far too good for men as they are, it is not less true that mere expediency does not of itself tend to establish a system of things any better than that which exists. While absolute morality owes to expediency the checks which prevent it from rushing into Utopian absurdities, expediency is indebted to absolute morality for all stimulus to improvement. Granted that we are chiefly interested in ascertaining what is *relatively right*, it still follows that we must first consider what is *absolutely right*; since the one conception presupposes the other."

And the comment I then made on these passages I may make now, that "I do not see how there could well be a more emphatic assertion that there exists a primary basis of morals independent of, and in a sense antecedent to, that which is furnished by experiences of utility; and consequently independent of, and in a sense antecedent to, those moral sentiments which I conceive to be generated by such experiences." I will only add that, had my beliefs been directly opposite to those I have enunciated

the reviewer might, I think, have found good reasons for his assertion. If, instead of demurring to the doctrine "that greatest happiness should be the *immediate* aim of man,"* I had endorsed that doctrine—if, instead of explaining and justifying "a belief in the special sacredness of these highest principles, and a sense of the supreme authority of the altruistic sentiments answering to them,"† I had denied the sacredness and the supreme authority—if, instead of saying of the wise man that "the highest truth he sees he will fearlessly utter; knowing that, let what may come of it, he is thus playing his right part in the world,"‡ I had said that the wise man will *not* do this; the reviewer might with truth have described me as not understanding "the term 'morality' according to the true sense of the word." And he might then have inferred that the Doctrine of Evolution as I hold it, implies denial of the "distinction between Duty and Pleasure." But as it is, I think the evidence will not generally be held to warrant his assertion.

I quite agree with the reviewer that the prevalence of a philosophy "is no mere question of speculative interest, but is one of the highest practical importance." I join him, too, in the belief that "calamitous social and political changes" may be the outcome of a mistaken philosophy. Moreover, writing as he does under the conviction that there can be no standard of right and wrong save one derived from a Revelation interpreted by an Infallible Authority, I can conceive the alarm with which he regards so radically opposed a system. Though I could have wished that the sense of justice he generally displays had prevented him from ignoring the evidence I have above given, I can understand how, from his point of view, the Doctrine of Evolution, as I understand it, "seems absolutely fatal

* *Social Statics*, chap. iii. † *Principles of Psychology*, § 531.
‡ *First Principles*, § 84.

to every germ of morality," and "entirely negatives every form of religion." But I am unable to understand that modified Doctrine of Evolution which the reviewer hints at as an alternative. For, little as the reader would anticipate it after these expressions of profound dissent, the reviewer displays such an amount of agreement as to suggest that the system he is criticizing might be converted, "rapidly and without violence, into an 'allotropic state,' in which its conspicuous characters would be startlingly diverse from those that it exhibits at present." May I, using a different figure, suggest a different transformation, having a subjective instead of an objective character? As in a stereoscope, the two views representing diverse aspects, often yield at first a jumble of conflicting impressions, but, after a time, suddenly combine into a single whole which stands out quite clearly; so, may it not be that the seemingly-inconsistent Idealism and Realism dwelt on by the reviewer, as well as the other seemingly-fundamental incongruities he is struck by, will, under more persistent contemplation, unite as complementary sides of the same thing?

My excuse for devoting some space to a criticism of so entirely different a kind as that contained in the *British Quarterly Review* for October, 1873, must be that, under the circumstances, I cannot let it pass unnoticed without seeming to admit its validity.

Saying that my books should be dealt with by specialists, and tacitly announcing himself as an expert in Physics, the reviewer takes me to task both for errors in the statement of physical principles and for erroneous reasoning in physics. That he discovers no mistakes I do not say. It would be marvellous if in such a multitude of propositions, averaging a dozen per page, I had made all criticism-proof. Some are inadvertencies which I should have been obliged to the reviewer for pointing out as such, but which he prefers to

instance as proving my ignorance. In other cases, taking advantage of an imperfection of statement, he proceeds to instruct me about matters which either the context, or passages in the same volume, show to be quite familiar to me. Here is a sample of his criticisms belonging to this class:—

"Nor should we counsel a man to venture upon physical speculations who converts the proposition '*heat is insensible motion*' into '*insensible motion is heat*,' and hence concludes that when a force is applied to a mass so large that no motion is seen to result from it, or when, as in the case of sound, motion gets so dispersed that it becomes insensible, it turns to heat."

Respecting the first of the two statements contained in this sentence, I will observe that the reader, if not misled by the quotation-marks into the supposition that I have made, in so many words, the assertion that "insensible motion is heat," will at any rate infer that this assertion is distinctly involved in the passage named. And he will infer that the reviewer would never have charged me with such an absurd belief, if there was before him evidence proving that I have no such belief. What will the reader say, then, when he learns, not simply that there is no such statement, and not simply that on the page referred to, which I have ascertained to be the one intended, there is no such implication visible, even to an expert (and I have put the question to one); but when he further learns that in other passages, the fact that heat is one only of the modes of insensible motion is distinctly stated (see *First Prin.* §§ 66, 68, 171); and when he learns that elsewhere I have specified the several forms of insensible motion? If the reviewer, who looks so diligently for flaws as to search an essay in a volume he is not reviewing to find one term of an incongruity, had sought with equal diligence to learn what I thought about insensible motion, he would have found in the *Classification of the Sciences*, Table II., that insensible motion is described by me as having the forms of Heat, Light, Electricity, Magnetism. Even had there been in

the place he names, an unquestionable implication of the belief which he ascribes to me, fairness might have led him to regard it as an oversight when he found it at variance with statements I have elsewhere made. What then is to be thought of him when, in the place named, no such belief is manifest; either to an ordinary reader or to a specially-instructed reader?

No less significant is the state of mind betrayed in the second clause of the reviewer's sentence. By representing me as saying that when the motion constituting sound "gets so dispersed that it becomes insensible, it turns to heat," does he intend to represent me as thinking that when sound-undulations become too weak to be audible, they become heat-undulations? If so, I reply that the passage he refers to has no such meaning. Does he then allege that some part of the force diffused in sound-waves is expended in generating electricity, by the friction of heterogeneous substances (which, however, eventually lapses from this special form of molecular motion in that general form constituting heat); and that I ought to have thus qualified my statement? If so, he would have had me commit a piece of scientific pedantry hindering the argument. If he does not mean either of these things, what does he mean? Does he contest the truth of the hypothesis which enabled Laplace to correct Newton's estimate of the velocity of sound—the hypothesis that heat is evolved by the compression each sound-wave produces in the air? Does he deny that the heat so generated is at the expense of so much wave-motion lost? Does he question the inference that some of the motion embodied in each wave is from instant to instant dissipated, partly in this way and partly in the heat evolved by fluid friction? Can he show any reason for doubting that when the sound-waves have become too feeble to affect our senses, their motion still continues to undergo this transformation and diminution until it is all lost? If not, why does he implicitly deny that

the molar motion constituting sound, eventually disappears in producing the molecular motion constituting heat?*

I will dwell no longer on the exclusively-personal questions raised by the reviewer's statements; but, leaving the reader to judge of the rest of my "stupendous mistakes" by the one I have dealt with, I will turn to a question worthy to occupy some space, as having an impersonal interest—the question, namely, respecting the nature of the warrant we have for asserting ultimate physical truths. The contempt which, as a physicist, the reviewer expresses for the metaphysical exploration of physical ideas, I will pass over with the remark that every physical question, probed to the bottom, opens into a metaphysical one; and that I should have thought the controversy now going on among chemists, respecting the legitimacy of the atomic hypothesis, might have shown him as much. On his erroneous statement that I use the phrase "Persistence of Force" as an equivalent for the now-generally-accepted phrase "Conservation of Energy," I will observe only that, had he not been in so great a hurry to find inconsistencies, he would have seen why, for the purposes of my argument,

* Only after the foregoing paragraphs were written, did the remark of a distinguished friend show me how certain words were misconstrued by the reviewer in a way that had never occurred to me as possible. In the passage referred to, I have said that sound-waves "finally die away in generating thermal undulations that radiate into space;" meaning, of course, that the force embodied in the sound-waves is finally *exhausted* in generating thermal undulations. In common speech, the dying-away of a prolonged sound, as that of a church-bell, includes its gradual diminution as well as its final cessation. But rather than suppose I gave to the words this ordinary meaning, the reviewer supposes me to believe, not simply that the *longitudinal* waves of air can pass, *without discontinuity*, into the *transverse* waves of ether, but he also debits me with the belief that the one order of waves, having lengths measurable in feet, and rates expressed in hundreds per second, can, *by mere enfeeblement*, pass into the other order of waves, having lengths of some fifty thousand to the inch, and rates expressed in many billions per second! Why he preferred so to interpret my words, and that, too, in the face of contrary implications elsewhere (instance § 100), will, however, be manifest to every one who reads his criticisms.

I intentionally use the word Force: Force being the generic word, including both that species known as Energy, and that species by which Matter occupies space and maintains its integrity—a species which, whatever may be its relation to Energy, and however clearly recognized as a necessary *datum* by the theory of Energy, is not otherwise considered in that theory. I will confine myself to the proposition, disputed at great length by the reviewer, that our cognition of the Persistence of Force is *a priori*. He relies much on the authority of Professor Tait, whom he twice quotes to the effect that—

"Natural philosophy is an experimental, and not an intuitive science. No *à priori* reasoning can conduct us demonstratively to a single physical truth."

Were I to take a hypercritical attitude, I might dwell on the fact that Professor Tait leaves the extent of his proposition somewhat doubtful, by speaking of "Natural philosophy" as *one* science. Were I to follow further the reviewer's example, I might point out that "Natural philosophy," in that Newtonian acceptation adopted by Professor Tait, includes Astronomy; and, going on to ask what astronomical "experiments" those are which conduct us to astronomical truths, I might then "counsel" the reviewer not to depend on the authority of one who (to use the reviewer's polite language) "blunders" by confounding experiment and observation. I will not, however, thus infer from Professor Tait's imperfection of statement that he is unaware of the difference between the two; and shall rate his authority as of no less value than I should, had he been more accurate in his expression. Respecting that authority I shall simply remark that, if the question had to be settled by the authority of any physicist, the authority of Mayer, who is diametrically opposed to Prof. Tait on this point, and who has been specially honoured, both by the Royal Society and by the French Institute, might well counter-weigh his, if not out-weigh it. I am not aware,

however, that the question is one in Physics. It seems to me a question respecting the nature of proof. And, without doubting Professor Tait's competence in Logic and Psychology, I should decline to abide by his judgment on such a question, even were there no opposite judgment given by a physicist, certainly of not less eminence.

Authority aside, however, let us discuss the matter on its merits. In the *Treatise on Natural Philosophy*, by Profs. Thomson and Tait, § 243 (1st ed.), I read that "as we shall show in our chapter on 'Experience,' physical axioms are axiomatic to those only who have sufficient knowledge of the action of physical causes to enable them to see at once their necessary truth." In this I agree entirely. It is in Physics, as it is in Mathematics, that before necessary truths can be grasped, there must be gained by individual experience, such familiarity with the elements of the thoughts to be framed, that propositions about those elements may be mentally represented with distinctness. Tell a child that things which are equal to the same thing are equal to one another, and the child, lacking a sufficiently-abstract notion of equality, and lacking, too, the needful practice in comparing relations, will fail to grasp the axiom. Similarly, a rustic, never having thought much about forces and their results, cannot form a definite conception answering to the axiom that action and reaction are equal and opposite. In the last case as in the first, ideas of the terms and their relations require to be made, by practice in thinking, so vivid that the involved truths may be mentally seen. But when the individual experiences have been multiplied enough to produce distinctness in the representations of the elements dealt with; then, in the one case as in the other, those mental forms generated by ancestral experiences, cannot be occupied by the elements of one of these ultimate truths without perception of its necessity. If Professor Tait does not admit this, what

does he mean by speaking of "physical *axioms*," and by saying that the cultured are enabled "to see *at once* their *necessary* truth?"

Again, if there are no physical truths which must be classed as *a priori*, I ask why Professor Tait joins Sir W. Thomson in accepting as bases for Physics, Newton's Laws of Motion? Though Newton gives illustrations of prolonged motion in bodies that are little resisted, he gives no *proof* that a body in motion will continue moving, if uninterfered with, in the same direction at the same velocity; nor, on turning to the enunciation of this law quoted in the above-named work, do I find that Professor Tait does more than exemplify it by facts which can themselves be asserted only by taking the law for granted. Does Professor Tait deny that the first law of motion is a physical truth? If so, what does he call it? Does he admit it to be a physical truth, and, denying that it is *a priori*, assert that it is established *a posteriori*—that is, by conscious induction from observation and experiment? If so, what is the inductive reasoning which can establish it? Let us glance at the several conceivable arguments which we must suppose him to rely on.

A body set in motion soon ceases to move if it encounters much friction, or much resistance from the bodies struck. If less of its energy is expended in moving, or otherwise affecting, other bodies, or in overcoming friction, its motion continues longer. And it continues longest when, as over smooth ice, it meets with the smallest amount of obstruction. May we then, proceeding by the method of concomitant variations, infer that were it wholly unobstructed its motion would continue undiminished? If so, we assume that the diminution of its motion observed in experience, is proportionate to the amount of energy abstracted from it in producing other motion, either molar or molecular. We assume that no variation has taken place in its rate, save that caused by deductions in moving other matter; for if

its motion be supposed to have otherwise varied, the conclusion that the differences in the distances travelled result from differences in the obstructions met with, is vitiated. Thus the truth to be established is already taken for granted in the premises. Nor is the question begged in this way only. In every case where it is remarked that a body stops the sooner, the more it is obstructed by other bodies or media, the law of inertia is assumed to hold in the obstructing bodies or media. The very conception of greater or less retardation so caused, implies the belief that there can be no retardations without proportionate retarding causes; which is itself the assumption otherwise expressed in the first law of motion.

Again, let us suppose that instead of inexact observations made on the movements occurring in daily experience, we make exact experiments on movements specially arranged to yield measured results; what is the postulate underlying every experiment? Uniform velocity is defined as motion through equal spaces in equal times. How do we measure equal times? By an instrument which can be inferred to mark equal times only if the oscillations of the pendulum are isochronous; which they can be proved to be only if the first and second laws of motion are granted. That is to say, the proposed experimental proof of the first law, assumes not only the truth of the first law, but of that which Professor Tait agrees with Newton in regarding as a second law. Is it said that the ultimate time-measure referred to is the motion of the Earth round its axis, through equal angles in equal times? Then the obvious rejoinder is that the assertion of this, similarly involves an assertion of the truth to be proved; since the undiminished rotatory movement of the Earth is itself a corollary from the first law of motion. Is it alleged that this axial movement of the Earth through equal angles in equal times, is ascertainable by reference to the stars? I answer that a developed system of Astronomy, leading through complex

reasonings to the conclusion that the Earth rotates, is, in that case, supposed to be needful before there can be established a law of motion which this system of Astronomy itself postulates. For even should it be said that the Newtonian theory of the Solar System is not necessarily pre-supposed, but only the Copernican; still, the proof of this assumes that a body at rest (a star being taken as such) will continue at rest; which is a part of the first law of motion, regarded by Newton as not more self-evident than the remaining part.

Not a little remarkable, indeed, is the oversight made by Professor Tait, in asserting that "no *a priori* reasoning can conduct us demonstratively to a single physical truth," when he has before him the fact that the system of physical truths constituting Newton's *Principia*, which he has joined Sir William Thomson in editing, is established by *a priori* reasoning. That there can be no change without a cause, or, in the words of Mayer, that "a force cannot become nothing, and just as little can a force be produced from nothing," is that ultimate dictum of consciousness on which all physical science rests. It is involved alike in the assertion that a body at rest will continue at rest, in the assertion that a body in motion must continue to move at the same velocity in the same line if no force acts on it, and in the assertion that any divergent motion given to it must be proportionate to the deflecting force; and it is also involved in the axiom that action and reaction are equal and opposite.

The reviewer's doctrine, in support of which he cites against me the authority of Professor Tait, illustrates in Physics that same error of the inductive philosophy which, in Metaphysics, I have pointed out elsewhere (*Principles of Psychology*, Part VII.). It is a doctrine implying that we can go on for ever asking the proof of the proof, without finally coming to any deepest cognition which is unproved and unprovable. That this is an untenable doctrine, I need

not say more to show. Nor, indeed, would saying more to show it be likely to have any effect, in so far at least as the reviewer is concerned; seeing that he thinks I am "ignorant of the very nature of the principles" of which I am speaking, and seeing that my notions of scientific reasoning "remind" him "of the Ptolemists," who argued that the heavenly bodies must move in circles because the circle is the most perfect figure.*

Not to try the reader's patience further, I will end by pointing out that, even were the reviewer's criticisms all valid, they would leave unshaken the theory he contends against. Though one of his sentences (p. 480) raises the expectation that he is about to assault, and greatly to damage, the bases of the system contained in the second part of *First Principles*, yet all those propositions which constitute the bases, he leaves, not only uninjured, but even untouched,—contenting himself with trying to show (with what success we have seen) that the fundamental one is an *a posteriori* truth and not an *a priori* truth. Against the general Doctrine of Evolution, considered as an induction from all classes of concrete phenomena, he utters not a word; nor does he utter a word to disprove any one of those laws of the redistribution of matter and motion, by

* Other examples of these amenities of controversy, in which I decline to imitate my reviewer, have already been given. What occasions he supplies me for imitation, were I minded to take advantage of them, an instance will show. Pointing out an implication of certain reasonings of mine, he suggests that it is too absurd even for me to avow explicitly; saying:—"We scarcely think that even Mr. Spencer will venture to claim as a datum of consciousness the Second Law of Motion, with its attendant complexities of component velocities, &c." Now any one who turns to Newton's *Principia*, will find that to the enunciation of the Second Law of Motion, nothing whatever is appended but an amplified re-statement—there is not even an illustration, much less a proof. And from this law, this axiom, this immediate intuition or "datum of consciousness," Newton proceeds forthwith to draw those corollaries respecting the composition of forces which underlie all dynamics. What, then, must be thought of Newton, who explicitly assumes that which the reviewer thinks it absurd to assume implicitly?

which the process of Evolution is deductively interpreted. Respecting the law of the Instability of the Homogeneous, he says no more than to quarrel with one of the illustrations. He makes no criticism on the law of the Multiplication of Effects. The law of Segregation he does not even mention. Nor does he mention the law of Equilibration. Further, he urges nothing against the statement that these general laws are severally deducible from the ultimate law of the Persistence of Force. Lastly, he does not deny the Persistence of Force; but only differs respecting the nature of our warrant for asserting it. Beyond pointing out, here a cracked brick and there a quoin set askew, he merely makes a futile attempt to show that the foundation is not natural rock, but concrete.

From his objections I may, indeed, derive much satisfaction. That a competent critic, obviously anxious to do all the mischief he can, and not over-scrupulous about the means he uses, has done so little, may be taken as evidence that the fabric of conclusions attacked will not be readily overthrown.

In the *British Quarterly Review* for January, 1874, the writer of the article I have dealt with above, makes a rejoinder. It is of the kind which might have been anticipated. There are men to whom the discovery that they have done injustice is painful. After proof of having wrongly ascribed to another such a nonsensical belief as that insensible motion is heat because heat is insensible motion, some would express regret. Not so my reviewer. Having by forced interpretations debited me with an absurdity, he makes no apology; but, with an air implying that he had all along done this, he attacks the allegation I had really made—an allegation which is at least so far from an absurdity, that he describes it only as not justified by "the present state of science." And here, having incidentally referred to this point, I may as well, before

proceeding, deal with his substituted charge at the same time that I further exemplify his method. Probably most of those who see the *British Quarterly*, will be favourably impressed by the confidence of his assertion; but those who compare my statement with his travesty of it, and who compare both with some authoritative exposition, will be otherwise impressed. To his statement that I conclude "that friction must ultimately transform *all* [the italics are his] the energy of a sound into heat," I reply that it is glaringly untrue: I have named friction as a second cause only. And when he pooh-poohs the effect of compression because it is "merely momentary," is he aware of the meaning of his words? Will he deny that, from first to last, during the interval of condensation, heat is being generated? Will he deny to the air the power of radiating such heat? He will not venture to do so. Take then the interval of condensation as one-thousandth of a second. I ask him to inform those whom he professes to instruct, what is the probable number of heat-waves which have escaped in this interval. Must they not be numbered by thousands of millions? In fact, by his "merely momentary," he actually assumes that what is momentary in relation to our time-measures, is momentary in relation to the escape of ethereal undulations!

Let me now proceed more systematically, and examine his rejoinder point by point. It sets out thus:—

"In the notice of Mr. Spencer's works that appeared in the last number of this *Review*, we had occasion to point out that he held mistaken notions of the most fundamental generalizations of dynamics; that he had shown an ignorance of the nature of proof in his treatment of the Newtonian Law; that he had used phrases such as the Persistence of Force in various and inconsistent significations; and more especially that he had put forth proofs logically faulty in his endeavour to demonstrate certain physical propositions by *à priori* methods, and to show that such proofs must exist. To this article Mr. Spencer has replied in the December number of the *Fortnightly Review*. His reply leaves every one of the above positions unassailed."

In my "Replies to Criticisms," which, as it was, trespassed unduly on the pages of the *Fortnightly Review*, I singled

out from those of his allegations which touched me personally, one that might be briefly dealt with as an example; and I stated that, passing over other personal questions, as not interesting to the general reader, I should devote the small space available to an impersonal one. Notwithstanding this, the reviewer, in the foregoing paragraph, enumerates his chief positions; asserts that I have not assailed any of them (which is untrue); and then leads his readers to the belief that I have not assailed them because they are unassailable.

Leaving this misbelief to be dealt with presently, I continue my comments on his rejoinder. After referring to the passage I have quoted from Prof. Tait's statement about physical axioms, and after indicating the nature of my criticism, the reviewer says:—

"Had Mr. Spencer, however, read the sentence that follows it, we doubt whether we should have heard aught of this quotation. It is 'Without further remark we shall give Newton's Three Laws; it being remembered that as the properties of matter might have been such as to render a totally different set of laws axiomatic, *these laws must be considered as resting on convictions drawn from observation and experiment and not on intuitive perception.*' This not only shows that the term 'axiomatic' is used in the previous sentence in a sense that does not exclude an inductive origin, but it leaves us indebted to Mr. Spencer for the discovery of the clearest and most authoritative expression of disapproval of his views respecting the nature of the Laws of Motion."

Let us analyze this "authoritative expression." It contains several startling implications, the disclosure of which the reader will find not uninteresting. Consider, first, what is implied by framing the thought that "the properties of matter might have been such as to render a totally different set of laws axiomatic." I will not stop to make the inquiry whether matter having properties fundamentally unlike its present ones, can be conceived; though such an inquiry, leading to the conclusion that no conception of the kind is possible, would show that the proposition is merely a verbal one. It will suffice if I examine the nature of this proposition that "the properties of matter *might have*

been" other than they are. Does it express an experimentally-ascertained truth? If so, I invite Prof. Tait to describe the experiments. Is it an intuition? If so, then along with doubt of an intuitive belief concerning things *as they are*, there goes confidence in an intuitive belief concerning things *as they are not*. Is it an hypothesis? If so, the implication is that a cognition of which the negation is inconceivable (for an axiom is such) may be discredited by inference from that which is not a cognition at all, but simply a supposition. Does the reviewer admit that no conclusion can have a validity greater than is possessed by its premises? or will he say that the trustworthiness of cognitions increases in proportion as they are the more inferential? Be his answer what it may, I shall take it as unquestionable that nothing concluded can have a warrant higher than that from which it is concluded, though it may have a lower. Now the elements of the proposition before us are these:—*As* "the properties of matter might have been such as to render a totally different set of laws axiomatic" [*therefore*] "these laws [now in force] must be considered as resting . . . not on intuitive perception:" that is, the intuitions in which these laws are recognized, must not be held authoritative. Here the cognition posited as premiss, is that the properties of matter might have been other than they are; and the conclusion is that our intuitions relative to existing properties are uncertain. Hence, if this conclusion is valid, it is valid because the cognition or intuition respecting what might have been, is more trustworthy than the cognition or intuition respecting what is! Scepticism respecting the deliverances of consciousness about things as they are, is based upon faith in a deliverance of consciousness about things as they are not!

I go on to remark that this "authoritative expression of disapproval" by which I am supposed to be silenced, even were its allegation as valid as it is fallacious, would leave

wholly untouched the real issue. I pointed out how Prof. Tait's denial that any physical truths could be reached *a priori*, was contradicted by his own statement respecting physical axioms. The question thus raised the reviewer evades, and substitutes another with which I have just dealt. Now I bring forward again the evaded question.

In the passage I quoted, Prof. Tait, besides speaking of physical "*axioms*," says of them that due familiarity with physical phenomena gives the power of seeing "*at once*" "their *necessary* truth." These last words, which express his conception of an axiom, express also the usual conception. An axiom is defined as a "self-evident truth," or a truth that is seen *at once;* and the definition otherwise worded is —a "truth so evident *at first sight*, that no process of reasoning or demonstration can make it plainer." Now I contend that Prof. Tait, by thus committing himself to a definition of physical axioms identical with that which is given of mathematical axioms, tacitly admits that they have the same *a priori* character; and I further contend that no such nature as that which he describes physical axioms to have, can be acquired by experiment or observation during the life of an individual. Axioms, if defined as truths of which the *necessity* is at once seen, are thereby defined as truths of which the negation is inconceivable; and the familiar contrast between them and the truths established by individual experiences, is that these last never become such that their negations are inconceivable, however multitudinous the experiences may be. Thousands of times has the sportsman heard the report that follows the flash from his gun, but still he can imagine the flash as occurring silently; and countless daily experiments on the burning of coal, leave him able to conceive coal as remaining in the fire without ignition. So that the "convictions drawn from observation and experiment" during a single life, can never acquire that character which Prof. Tait admits physical axioms to have: in other words, physical axioms cannot be

derived from personal observation and experiment. Thus, otherwise applying the reviewer's words, I "doubt whether we should have heard aught of this quotation" to which he calls my attention, had he studied the matter more closely; and he "leaves us indebted to" him "for the discovery of" a passage which serves to make clearer the untenability of the doctrine he so dogmatically affirms.

I turn now to what the reviewer says concerning the special arguments I used to show that the first law of motion cannot be proved experimentally. After a bare enunciation of my positions, he says:—

"On the utterly erroneous character of these statements we do not care to dwell, we wish simply to call our reader's attention to the conclusion arrived at. Is that a disproof of the possibility of an inductive proof? We thought that every tolerably educated man was aware that the proof of a scientific law *consisted in* showing that *by* assuming its truth, we could explain the observed phenomena."

Probably the reviewer expects his readers to conclude that he could easily dispose of the statements referred to if he tried. Among scientific men, however, this cavalier passing over of my arguments will perhaps be ascribed to another cause. I will give him my reason for saying this. Those arguments, read in proof by one of the most eminent physicists, and by a specially-honoured mathematician, had their entire concurrence; and I have since had from another mathematician, standing among the very first, such qualified agreement as is implied in saying that the first law of motion cannot be proved by terrestrial observations (which is in large measure what I undertook to show in the paragraphs which the reviewer passes over so contemptuously). But his last sentence, telling us what he thought "every tolerably educated man was aware" of, is the one which chiefly demands attention. In it he uses the word *law*—a word which, conveniently wide in meaning, suits his purpose remarkably well. But we are here speaking of physical *axioms*. The question is whether the justification of a physical

axiom consists in showing that by assuming its truth, we can explain the observed phenomena. If it does, then all distinction between hypothesis and axiom disappears. Mathematical axioms, for which there is no other definition than that which Prof. Tait gives of physical axioms, must stand on the same footing. Henceforth we must hold that our warrant for asserting that "things which are equal to the same thing are equal to one another," consists in the observed truth of the geometrical and other propositions deducible from it and the associated axioms—the *observed* truth, mind; for the fabric of deductions yields none of the required warrant until these deductions have been tested by measurement. When we have described squares on the three sides of a right-angled triangle, cut them out in paper, and, by weighing them, have found that the one on the hypothenuse balances the other two; then we have got a fact which, joined with other facts similarly ascertained, justifies us in asserting that things which are equal to the same thing are equal to one another! Even as it stands, this implication will not, I think, be readily accepted; but we shall find that its unacceptability becomes still more conspicuous when the analysis is pursued to the end.

Continuing his argument to show that the laws of motion have no *a priori* warrant, the reviewer says:—

"Mr. Spencer asserts that Newton gave no proof of the Laws of Motion. The whole of the *Principia* was the proof, and the fact that, taken as a system, these laws account for the lunar and planetary motions, is the warrant on which they chiefly rest to this day."

I have first to point out that here, as before, the reviewer escapes by raising a new issue. I did not ask what he thinks about the *Principia*, and the proof of the laws of motion by it; nor did I ask whether others at this day, hold the assertion of these laws to be justified mainly by the evidence the Solar System affords. I asked what Newton thought. The reviewer had represented the belief that the second law of motion is knowable *a priori*, as too

absurd even for me openly to enunciate. I pointed out that since Newton enunciates it openly under the title of an axiom, and offers no proof whatever of it, he did explicitly what I am blamed for doing implicitly. And thereupon I invited the reviewer to say what he thought of Newton. Instead of answering, he gives me his opinion to the effect that the laws of motion are proved true by the truth of the *Principia* deduced from them. Of this hereafter. My present purpose is to show that Newton did not say this, and gave every indication of thinking the contrary. He does not call the laws of motion "hypotheses;" he calls them "axioms." He does not say that he assumes them to be true *provisionally*; and that the warrant for accepting them as actually true, will be found in the astronomically-proved truth of the deductions. He lays them down just as mathematical axioms are laid down—posits them as truths to be accepted *a priori*, from which follow consequences that must therefore be accepted. And though the reviewer thinks this an untenable position, I am quite content to range myself with Newton in thinking it a tenable one—if, indeed, I may say so without undervaluing the reviewer's judgment. But now, having shown that the reviewer evaded the issue I raised, which it was inconvenient for him to meet, I pass to the issue he substitutes for it. I will first deal with it after the methods of ordinary logic, before dealing with it after the methods of what may be called transcendental logic.

To establish the truth of a proposition postulated, by showing that the deductions from it are true, requires that the truth of the deductions shall be shown in some way that does not directly or indirectly assume the truth of the proposition postulated. If, setting out with the axioms of Euclid, we deduce the truths that "the angle in a semicircle is a right angle," and that "the opposite angles of any quadrilateral figure described in a circle, are together equal to two right angles," and so forth; and if, because

these propositions are true, we say that the axioms are true, we are guilty of a *petitio principii*. I do not mean simply that if these various propositions are taken as true on the strength of the demonstrations given, the reasoning is circular, because the demonstrations assume the axioms; but I mean more—I mean that any supposed *experimental* proof of these propositions by measurement, itself assumes the axioms to be justified. For even when the supposed experimental proof consists in showing that some two lines demonstrated by reason to be equal, are equal when tested in perception, the axiom that things which are equal to the same thing are equal to one another, is taken for granted. The equality of the two lines can be ascertained only by carrying from the one to the other, some measure (either a moveable marked line or the space between the points of compasses), and by assuming that the two lines are equal to one another, because they are severally equal to this measure. The ultimate truths of mathematics, then, cannot be established by any experimental proof that the deductions from them are true; since the supposed experimental proof takes them for granted. The same thing holds of ultimate physical truths. For the alleged *a posteriori* proof of these truths, has a vice exactly analogous to the vice I have just indicated. Every evidence yielded by astronomy that the axioms called "the laws of motion" are true, resolves itself into a fulfilled prevision that some celestial body or bodies, will be seen in a specified place, or in specified places, in the heavens, at some assigned time. Now the day, hour, and minute of this verifying observation, can be fixed only on the assumption that the Earth's motion in its orbit and its motion round its axis, continue undiminished. Mark, then, the parallelism. One who chose to deny that things which are equal to the same thing are equal to one another, could never have it proved to him by showing the truth of deduced propositions; since the testing process would in

every case assume that which he denied. Similarly, one who refused to admit that motion, uninterfered with, continues in the same straight line at the same velocity, could not have it proved to him by the fulfilment of an astronomical prediction; because he would say that both the spectator's position in space, and the position of the event in time, were those alleged, only if the Earth's motions of translation and rotation were undiminished, which was the very thing he called in question. Evidently such a sceptic might object that the seeming fulfilment of the prediction, say a transit of Venus, may be effected by various combinations of the changing positions of Venus, of the Earth, and of the spectator on the Earth. The appearances may occur as anticipated, though Venus is at some other place than the calculated one; provided the Earth also is at some other place, and the spectator's position on the Earth is different. And if the first law of motion is not assumed, it must be admitted that the Earth and the spectator *may* occupy these other places at the predicted time: supposing that in the absence of the first law, this predicted time can be ascertained, which it cannot. Thus the testing process inevitably begs the question.

That the perfect congruity of all astronomical observations with all deductions from "the laws of motion," gives coherence to this group of intuitions and perceptions, and so furnishes a warrant for the entire aggregate of them which it would not have were any of them at variance, is unquestionable. But it does not therefore follow that astronomical observations can furnish a test for *each individual assumption*, out of the many which are simultaneously made. I will not dwell on the fact that the process of verification assumes the validity of the assumptions on which acts of reasoning proceed; for the reply may be that these are shown to be valid apart from astronomy. Nor will I insist that the assumptions underlying mathematical inferences, geometrical and nume-

rical, are involved; since it may be said that these are justifiable separately by our terrestrial experiences. But, passing over all else that is taken for granted, it suffices to point out that, in making every astronomical prediction, the three laws of motion and the law of gravitation are *all* assumed; that if the first law of motion is to be held proved by the fulfilment of the prediction, it can be so only by taking for granted that the two other laws of motion and the law of gravitation are true; and that non-fulfilment of the prediction would not disprove the first law of motion, since the error might be in one or other of the three remaining assumptions. Similarly with the second law: the astronomical proof of it depends on the truth of the accompanying assumptions. So that the warrants for the assumptions A, B, C, and D, are respectively such that A, B, and C being taken as trustworthy, prove the validity of D; D being thus proved valid, joins C, and B, in giving a character to A; and so throughout. The result is that everything comes out right if they happen to be all true; but if one of them is false, it may destroy the characters of the other three, though these are in reality exact. Clearly, then, astronomical prediction and observation can never test any one of the premises by itself. They can only justify the entire aggregate of premises, mathematical and physical, joined with the entire aggregate of reasoning processes leading from premises to conclusions.

I now recall the reviewer's "thought," uttered in his habitual manner, "that every tolerably educated man was aware that the proof of a scientific law *consisted in* showing that *by* assuming its truth, we could explain the observed phenomena." Having from the point of view of ordinary logic dealt with this theory of proof as applied by the reviewer, I proceed to deal with it from the point of view of transcendental logic, as I have myself applied it. And here I have to charge the reviewer with either being ignorant of, or else deliberately ignoring, a cardinal doc-

trine of the System of Philosophy he professes to review—a doctrine set forth not in those four volumes of it which he seems never to have looked into; but in the one volume of it he has partially dealt with. For this principle which, in respect to scientific belief, he enunciates for my instruction, is one which, in *First Principles*, I have enunciated in respect to all beliefs whatever. In the chapter on the "Data of Philosophy," where I have inquired into the legitimacy of our modes of procedure, and where I have pointed out that there are certain ultimate conceptions without which the intellect can no more stir "than the body can stir without help of its limbs," I have inquired how their validity or invalidity is to be shown; and I have gone on to reply that—

"Those of them which are vital, or cannot be severed from the rest without mental dissolution, must be assumed as true *provisionally* . . . . leaving the assumption of their unquestionableness to be justified by the results.

"§ 40. How is it to be justified by the results? As any other assumption is justified—by ascertaining that all the conclusions deducible from it, correspond with the facts as directly observed—by showing the agreement between the experiences it leads us to anticipate, and the actual experiences. There is no mode of establishing the validity of any belief, except that of showing its entire congruity with all other beliefs."

Proceeding avowedly and rigorously on this principle, I have next inquired what is the fundamental *process* of thought by which this congruity is to be determined, and what is the fundamental *product* of thought yielded by this process. This fundamental product I have shown to be the coexistence of subject and object; and then, describing this as a postulate to be justified by "its subsequently-proved congruity with every result of experience, direct and indirect," I have gone on to say that "the two divisions of self and not-self, are re-divisible into certain most general forms, the reality of which Science, as well as Common Sense, from moment to moment assumes." Nor is this all. Having thus assumed, *only provisionally*, this deepest of all intuitions, far transcending an axiom in self-evidence, I

have, after drawing deductions occupying four volumes, deliberately gone back to the assumption (*Prin. of Psy.*, § 386). After quoting the passage in which the principle was laid down, and after reminding the reader that the deductions drawn had been found congruous with one another; I have pointed out that it still remained to ascertain whether this primordial assumption was congruous with all the deductions; and have thereupon proceeded, throughout eighteen chapters, to show the congruity. And yet having before him the volumes in which this principle is set forth with a distinctness, and acted upon with a deliberation, which I believe are nowhere paralleled, the reviewer enunciates for my benefit this principle of which he "thought that every tolerably educated man was aware"! He enunciates it as applying to limited groups of beliefs, to which it does not apply; and shuts his eyes to the fact that I have avowedly and systematically acted upon it in respect to the entire aggregate of our beliefs (axioms included) for which it furnishes the ultimate justification!

Here I must add another elucidatory statement, which would have been needless had the reviewer read that which he criticizes. His argument proceeds throughout on the assumption that I understand *a priori* truths after the ancient manner, as truths independent of experience; and he shows this more tacitly, where he "trusts" that he is "attacking one of the last attempts to deduce the laws of nature from our inner consciousness." Manifestly, a leading thesis of one of the works he professes to review, is entirely unknown to him—the thesis that forms of thought, and consequently the intuitions which those forms of thought involve, result entirely from the effects of experiences, organized and inherited. With the *Principles of Psychology* before him, not only does he seem unaware that it contains this doctrine, but though this doctrine, set forth in its first edition published nearly twenty years ago, has gained

considerable currency, he seems never to have heard of it. The implication of this doctrine is, not that the "laws of nature" are deducible from "our inner consciousness," but that our consciousness has a pre-established correspondence with such of those laws (simple, perpetually presented, and never negatived) as have, in the course of practically-infinite ancestral experiences, registered themselves in our nervous structure. Had he taken the trouble to acquaint himself with this doctrine, he would have learned that the intuitions of axiomatic truths are regarded by me as latent in the inherited brain, just as bodily reflex actions are latent in the inherited nervous centres of a lower order; that such latent intuitions are made potentially more distinct by the greater definiteness of structure due to individual action and culture; and that thus, axiomatic truths, having a warrant entirely *a posteriori* for the race, have for the individual a warrant which, substantially *a priori*, is made complete *a posteriori*. And he would then have learned that as, during evolution, Thought has been moulded into increasing correspondence with Things; and as such correspondence, tolerably complete in respect of the simple, ever-present, and invariable relations, as those of space, has made considerable advance in respect of the primary dynamical relations; the assertion that the resulting intuitions are authoritative, is the assertion that the simplest uniformities of nature, as experienced throughout an immeasurable past, are better known than they are as experienced during an individual life. All which conceptions, however, being, as it seems, unheard of by the reviewer, he regards my trust in these primordial intuitions as like that of the Ptolemists in their fancies about perfection!

Thus far my chief antagonists, passive if not active, have been Prof. Tait and, by implication, Sir William Thomson,

his coadjutor in the work quoted against me—men of standing, and the last of them of world-wide reputation as a mathematician and physicist. Partly because the opinions of such men demand attention, I have dealt with the questions raised at some length; and partly, also, because the origin and consequent warrant of physical axioms are questions of general and permanent interest. The reviewer, who by citing against me these authorities has gained for some of his criticisms consideration they would otherwise not deserve, I must, in respect of his other criticisms, deal with very briefly. Because, for reasons sufficiently indicated, I did not assail sundry of his statements, he has reiterated them as unassailable. I will here add no more than is needful to show how groundless is his assumption.

What the reviewer says on the metaphysical aspects of the propositions we distinguish as physical, need not detain us long. His account of my exposition of "Ultimate Scientific Ideas," he closes by saying of me that "he is not content with less than showing that all our fundamental conceptions are inconceivable." Whether the reviewer knows what he means by an inconceivable conception, I cannot tell. It will suffice to say that I have attempted no such remarkable feat as that described. My attempt has been to show that objective activities, together with their objective forms, are inconceivable by us—that such symbolic conceptions of them as we frame, and are obliged to use, are proved, by the alternative contradictions which a final analysis of them discloses, to have no likeness to the realities. But the proposition that objective existence cannot be rendered in terms of subjective existence, the reviewer thinks adequately expressed by saying that "our fundamental conceptions" (subjective products) "are inconceivable" (cannot be framed by subjective processes)! Giving this as a sample from which may be judged his fitness for discussing these ultimate questions, I pass over his physico-metaphysical criticisms, and proceed at once to

those which his special discipline may be assumed to render more worthy of attention.

Quoting a passage relative to the law that "all central forces vary inversely as the squares of the distances," he derides the assertion that "this law is not simply an empirical one, but one deducible mathematically from the relations of space—one of which the negation is inconceivable." Now whether this statement can or cannot be fully justified, it has at any rate none of that absurdity alleged by the reviewer. When he puts the question—"Whence does he [do I] get this?" he invites the suspicion that his mind is not characterized by much excursiveness. It seems never to have occurred to him that, if rays like those of light radiate in straight lines from a centre, the number of them falling on any given area of a sphere described from that centre, will diminish as the square of the distance increases, because the surfaces of spheres vary as the squares of their radii. For, if this has occurred to him, why does he ask whence I get the inference? The inference is so simple a one as naturally to be recognized by those whose thoughts go a little beyond their lessons in geometry.* If the reviewer means to ask, whence I get the implied assumption that central forces act only in straight lines, I reply that this assumption has a warrant akin to that of Newton's first axiom, that a moving body will continue moving in a straight line unless interfered with. For that the force exerted by one centre on another should act in a curved line, implies the conception of some second force, complicating the direct effect of the first. And, even could a central force be truly conceived as acting in lines not straight, the *average* distri-

* That I am certainly not singular in this view, is shown to me, even while I write, by the just-issued work of Prof. Jevons on the *Principles of Science: a Treatise on Logic and Scientific Method.* In vol. ii., p. 141, Prof. Jevons remarks respecting the law of variation of the attractive force, that it "is doubtless connected at this point with the primary properties of space itself, and is so far conformable to our necessary ideas."

bution of its effects upon the inner surface of the surrounding sphere, would still follow the same law. Thus, whether or not the law be accepted on *a priori* grounds, the assumed absurdity of representing it to have *a priori* grounds, is not very obvious. Respecting this statement of mine the reviewer goes on to say—

"This is a wisdom far higher than that possessed by the discoverer of the great law of attraction, who was led to consider it from no cogitations on the relations of space, but from observations of the movements of the planets; and who was so far from rising to that clearness of view of the truth of his great discovery, which is expressed by the phrase, 'its negation is inconceivable,' that he actually abandoned it for a time, because (through an error in his estimate of the earth's diameter) it did not seem fully to account for the motion of the moon."

To the first clause in this sentence, I have simply to give a direct denial; and to assert that neither Newton's "observations of the movements of the planets" nor other such observations continued by all astronomers for all time, would yield "the great law of attraction." Contrariwise, I contend that when the reviewer says, by implication, that Newton had no antecedent hypothesis respecting the cause of the planetary motions, he (the reviewer) is not only going beyond his possible knowledge, but he is asserting that which even a rudimentary acquaintance with the process of discovery, might have shown him was impossible. Without framing, beforehand, the supposition that there was at work an attractive force varying inversely as the square of the distance, no such comparison of observations as that which led to the establishment of the theory of gravitation could have been made. On the second clause of the sentence, in which the reviewer volunteers for my benefit the information that Newton "actually abandoned" his hypothesis for a while because it did not bring out right results, I have first to tell him that, in an early number of the very periodical containing his article,* I cited this fact

* See Essay on "The Genesis of Science," in the *British Quarterly Review* for July, 1854, p. 127.

(using these same words) at a time when he was at school, or before he went there.* I have next to assert that this fact is irrelevant; and that Newton, while probably seeing it to be a necessary implication of geometrical laws that central forces vary inversely as the squares of the distances, did not see it to be a necessary implication of any laws, geometrical or dynamical, that there exists a force by which the celestial bodies affect one another; and therefore doubtless saw that there was no *a priori* warrant for the doctrine of gravitation. The reviewer, however, aiming to substitute for my "confused notions" his own clear ones, wishes me to identify the proposition—Central forces vary inversely as the squares of the distances—with the proposition—There exists a cosmical attractive force which varies inversely as the squares of the distances. But I decline to identify them; and I suspect that a considerable distinction between them was recognized by Newton. Lastly, apart from all this, I have to point out that even had Newton thought the existence of an attractive force throughout space was an *a priori* truth, as well as the law of variation of such a force if it existed; he would still, naturally enough, pause before asserting gravitation and its law, when he found his deductions did not correspond with the facts. To suppose otherwise, is to ascribe to him a rashness which no disciplined man of science could be guilty of.

See, then, the critical capacity variously exhibited in the space of a single sentence. The reviewer, quite erroneously, thinks that observations unguided by hypotheses suffice for physical discoveries. He seems unaware that, on *a priori* grounds, the law of the inverse square had been suspected as the law of some cosmical force, before Newton. He asserts, without warrant, that no such *a priori* conception preceded, in Newton's mind, his observations and

* I do not say this at random. The reviewer, who has sought rather to make known than to conceal his identity, took his degree in 1868.

calculations. He confounds the law of variation of a force, with the existence of a force varying according to that law. And he concludes that Newton could have had no *a priori* conception of the law of variation, because he did not assert the existence of a force varying according to this law in defiance of the evidence as then presented to him!

Now that I have analyzed, with these results, the first of his criticisms, the reader will neither expect me to waste time in similarly dealing with the rest *seriatim*, nor will he wish to have his own time occupied in following the analysis. To the evidence thus furnished of the reviewer's fitness for the task he undertakes, it will suffice if I add an illustration or two of the *animus* which leads him to make grave imputations on trivial grounds, and to ignore the evidence which contradicts his interpretations.

Because I have spoken of a balanced system, like that formed by the sun and planets, as having the "peculiarity, that though the constituents of the system have relative movements, the system, as a whole, has no movement," he unhesitatingly assumes me to be unaware that in a system of bodies whose movements are not balanced, it is equally true that the centre of gravity remains constant. Ignorance of a general principle in dynamics is alleged against me solely because of this colloquial use of the word "peculiarity," where I should have used a word (and there is no word perfectly fit) free from the implication of exclusiveness. If the reviewer were to assert that arrogance is a "peculiarity" of critics; and if I were thereupon to charge him with entire ignorance of mankind, many of whom besides critics are arrogant, he would rightly say that my conclusion was a very large one to draw from so small a premise.

To this example of strained inference I will join an example of what seems like deliberate misconstruction. From one of my essays (not among the works he professes to deal with) the reviewer, to strengthen his attack, brings

a strange mistake; which, even without inquiry, any fair-minded reader would see must be an oversight. A statement true of a single body acted on by a tractive force, I have inadvertently pluralized: being so possessed by another aspect of the question, as to overlook the obvious fact that with a plurality of bodies the statement became untrue. Not only, however, does the reviewer ignore various evidences furnished by the works before him, that I could not really think what I had there said, but he ignores a direct contradiction contained in the paragraph succeeding that from which he quotes. So that the case stands thus:—On two adjacent pages I have made two opposite statements, both of which I cannot be supposed to believe. One of them is right; and this the reviewer assumes I do not believe. One of them is glaringly wrong; and this the reviewer assumes I do believe. Why he made this choice no one who reads his criticism will fail to see.

Even had his judgments more authority than is given to them by his mathematical honours, this brief characterization would, I think, suffice. Perhaps already, in rebutting the assumption that I did not answer his allegations because they were unanswerable, I have ascribed to them an unmerited importance. For the rest, suggesting that their value may be measured by the value of that above dealt with as a sample, I leave them to be answered by the works they are directed against.

Here I end. The foregoing pages, while serving, I think, the more important purpose of making clearer the relations of physical axioms to physical knowledge, incidentally justify the assertion that the reviewer's charges of fallacious reasoning and ignorance of the nature of proof, recoil on himself. When, in his confident way, he undertakes to teach me the nature of our warrant for scientific beliefs, ignoring absolutely the inquiry contained in *Principles of Psychology*, concerning the relative values of direct intuitions and reasoned conclusions, he lays himself open to

a sarcasm which is sufficiently obvious. And when a certain ultimate principle of justification for our beliefs, set forth and acted upon in the *System of Synthetic Philosophy* more distinctly than in any other work, is enunciated by him for my instruction, as one which he "thought that every tolerably educated man was aware" of, his course is one for which I find no fit epithet in the vocabulary I permit myself to use. That in some cases he has shown eagerness to found charges on misinterpretations little less than deliberate, has been sufficiently shown; as also that, in other cases, his own failure to discriminate is made the ground for ascribing to me beliefs that are manifestly untenable. Save in the single case of a statement respecting collisions of bodies, made by me without the needful qualification, I am not aware of any errors he detects, except errors of oversight or those arising from imperfect expression and inadequate exposition. When he unhesitatingly puts the worst constructions on these, it cannot be because his own exactness is such that no other constructions occur to him; for he displays an unusual capacity for inadvertencies, and must have had many experiences showing him how much he might be wronged by illiberal interpretations of them. One who in twenty-three professed extracts makes fifteen mistakes—words omitted, or added, or substituted—should not need reminding how largely mere oversight may raise suspicion of something worse. One who shows his notions of accurate statement by asserting that as I substitute "persistence" for "conservation," I therefore identify Persistence of *Force* with Conservation of *Energy*, and debits me with the resulting incongruities—one who, in pursuance of this error, confounds a special principle with the general principle it is said to imply, and thereupon describes a wider principle as being included in a narrower (p. 481)—one who speaks of our "inner consciousness" (p. 488), so asserting, by implication, that we have an outer consciousness—one who

talks of an inconceivable conception; ought surely to be aware how readily lax expressions may be turned into proofs of absurd opinions. And one who, in the space of a few pages, falls into so many solecisms; ought to be vividly conscious that a whole volume thus written would furnish multitudinous statements from which a critic, moved by a spirit like his own, might evolve abundant absurdities; supplying ample occasion for blazoning the tops of pages with insulting words.

[*A letter, drawn from Prof. Tait by the foregoing criticisms, and published by him in* Nature, *initiated a controversy carried on in that periodical between March 26th and June 18th,* 1874. *Partly in justification of my position, and partly as tending to make clearer the nature and origin of physical axioms, I append certain portions of the correspondence, with some additional explanations and comments. For the purpose of elucidation I prefix the theses I have maintained.*]

THESES.

1. *If A produces B, then 2 A will produce 2 B.*

This is the blank form of causal relation quantitatively considered, when the causes and effects are simple—that is, are unimpeded by other causes and uncomplicated by other effects; and whenever two or more causes co-operate, there is no possibility of determining the relation between the compound cause and the compound effect except by assuming that between each co-operating cause and its separate effect there exists this same quantitative relation.

2. *This truth holds whatever the natures of the simple causes and simple effects; and is an* a priori *assumption made in conducting every experiment and in reasoning from it.*

Every process of weighing, every chemical analysis, every physical investigation, proceeds on this truth without assigning warrant for it; and in allowing for the effect of any minor cause that interferes with the major cause, this same truth is assumed.

3. *When A is an impressed force and B the produced motion, then the general truth that if A produces B, 2 A will produce 2 B, becomes the more special truth called the Second Law of Motion.*

Newton's amplified statement of this Law is:—"If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively." And his further clause, asserting that this law holds whether the directions of the forces are or are not the same, asserts a proportionality between each force and its produced motion, such as we have seen to be invariably assumed between each cause and its separate effect, when there are co-operating causes.

4. *This Law may be affirmed, without specification of the modes in which the impressed force and the resulting motion are to be estimated.*

Newton's statement is abstract. Taking for granted right modes of measurement, it asserts that the alteration of motion (rightly measured) is proportional to the impressed force (rightly measured).

5. *No* a posteriori *proof of the general ultimate physical truth (or of this more special truth it includes) is possible; because every supposed process of verification assumes it.*

These, cleared from entanglements, are the theses held by me, and defended in the following pages.

APPENDIX A.

(*From* Nature, *April* 16, 1874.)

ABSENCE from town has delayed what further remarks I have to make respecting the disputed origin of physical axioms.

The particular physical axiom in connection with which the general question was raised, was the Second Law of Motion. It stands in the *Principia* as follows:—

"*The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*

"If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively. And this motion (being always directed the same way with the generating force), if the body moved before, is added to or subducted from the former motion, according as they directly conspire with or are directly contrary to each other; or obliquely joined, when they are oblique, so as to produce a new motion compounded from the determination of both."

As this, like each of the other Laws of Motion, is called an axiom;* as the paragraph appended to it is simply an amplification, or re-statement in a more concrete form; as there are no facts named as bases of induction, nor any justifying experiment; and as Newton proceeds forthwith to draw deductions; it was a legitimate inference that he regarded this truth as *a priori*. My statement to this effect was based on the contents of the *Principia* itself; and I think I was warranted in assuming that the nature of the Laws of Motion, as conceived by Newton, was to be thence inferred.

The passages quoted by the *British Quarterly* Reviewer from Newton's correspondence, which were unknown to me, show that this was not Newton's conception of them. Thus far, then, my opponent has the best of the argu-

* It is true that in Newton's time, "axiom" had not the same rigorously defined meaning as now; but it suffices for my argument that, *standing unproved* as a basis for physical deductions, it bears just the same relation to them that a mathematical axiom does to mathematical deductions.

ment. Several qualifying considerations have to be set down, however.

(1) Clearly, the statements contained in the *Principia* do not convey Newton's conception; otherwise there would have been no need for his explanations. The passages quoted prove that he wished to exclude these cardinal truths from the class of hypotheses, which he said he did not make; and to do this he had to define them.

(2) By calling them "axioms," and by yet describing them as principles "*deduced* from phenomena," he makes it manifest that he gives the word "axiom" a sense widely unlike the sense in which it is usually accepted.

(3) Further, the quotations fail to warrant the statement that the Laws of Motion are proved true by the truth of the *Principia*. For if the fulfilment of astronomical predictions made in pursuance of the *Principia*, is held to be the evidence "on which they chiefly rest to this day," then, until thus justified, they are unquestionably hypotheses. Yet Newton says they are not hypotheses.

Newton's view may be found without seeking for it in his letters: it is contained in the *Principia* itself. The scholium to Corollary VI. begins thus:—

"Hitherto I have laid down such principles as have been received by mathematicians, and are *confirmed* by abundance of experiments. By the two first Laws and the two first Corollaries, Galileo discovered that the descent of bodies observed the duplicate ratio of the time, and that the motion of projectiles was in the curve of a parabola; experience *agreeing* with both," &c.

Now as this passage precedes the deductions constituting the *Principia*, it shows conclusively, in the first place, that Newton did not think "the whole of the *Principia* was the proof" of the Laws of Motion, though the Reviewer asserts that it is. Further, by the words I have italicised, Newton implicitly describes Galileo as having asserted these Laws of Motion, if not as gratuitous hypotheses (which he says they are not), then as *a priori* intuitions. For a proposition which is *confirmed* by

experiment, and which is said to *agree* with experience, must have been entertained before the alleged verifications could be reached. And as before he made his experiments on falling bodies and projectiles, Galileo had no facts serving as an inductive basis for the Second Law of Motion, the law could not have been arrived at by induction.

Let me end what I have to say on this vexed question by adding a further reason to those I have already given, for saying that physical axioms cannot be established experimentally. The belief in their experimental establishment rests on the tacit assumption that experiments can be made, and conclusions drawn from them, without any truths being postulated. It is forgotten that there is a foundation of pre-conceptions without which the perceptions and inferences of the physicist cannot stand—*pre-conceptions which are the products of simpler experiences than those yielded by consciously-made experiments.* Passing over the many which do not immediately concern us, I will name only that which does,—the exact quantitative relation [of proportionality] between cause and effect. It is taken by the chemist as a truth needing no proof, that if two volumes of hydrogen unite with one volume of oxygen to form a certain quantity of water, four volumes of hydrogen uniting with two volumes of oxygen will form double the quantity of water. If a cubic foot of ice at 32° is liquefied by a specified quantity of heat, it is taken to be unquestionable that three times the quantity of heat will liquefy three cubic feet. And similarly with mechanical forces, the unhesitating assumption is that if one unit of force acting in a given direction produces a certain result, two units will produce twice the result. Every process of measurement in a physical experiment takes this for granted; as we see in one of the simplest of them—the process of weighing. If a measured quantity of metal, gravitating towards the Earth, counterbalances a quantity of some other substance, the truth postulated in every act

of weighing is, that any multiple of such weight will counterbalance an equi-multiple of such substance. That is to say, each unit of force is assumed to work its equivalent of effect in the direction in which it acts. Now this is nothing else than the assumption which the Second Law of Motion expresses in respect to effects of another kind. "If any force generates a motion, a double force will generate a double motion," &c., &c.; and when carried on to the composition of motions, the law is, similarly, the assertion that any other force, acting in any other direction, will similarly produce in that direction a proportionate motion. So that the law simply asserts the exact equivalence [or proportionality] of causes and effects of this particular class, while all physical experiments *assume* this exact equivalence [or proportionality] among causes and effects of all classes. Hence, the proposal to prove the Laws of Motion experimentally, is the proposal to make a wider assumption for the purpose of justifying one of the narrower assumptions included in it.

Reduced to its briefest form, the argument is this:—If definite quantitative relations [of proportionality] between causes and effects be assumed *a priori*, then, the Second Law of Motion is an immediate corollary. If there are not definite quantitative relations [of proportionality] between causes and effects, all the conclusions drawn from physical experiments are invalid. And further, in the absence of this *a priori* assumption of equivalence, the quantified conclusion from any experiment may be denied, and any other quantification of the conclusion asserted.*

HERBERT SPENCER.

Entire misconstruction of the view expressed above,

* The above letter, written after absence at Easter had involved a week's delay, and written somewhat hurriedly to prevent the delay of a second week, was less carefully revised than it should have been. The words in square brackets, obviously implied by the reasoning, and specifically implied by the illustrations, were not in the letter as originally published.

having been shown by a new assailant, who announced himself as also "A Senior Wrangler," Mr. James Collier [my secretary at that time] wrote on my behalf an explanatory letter, published in *Nature* for May 21, 1874, from which the following passages are extracts:—

"The cue may be taken from an experience described in Mr. Spencer's *Principles of Psychology* (§ 468, note), where it is shown that when with one hand we pull the other, we have in the feeling of tension produced in the limb pulled, a measure of the reaction that is equivalent to the action of the other limb. Both terms of the relation of cause and effect are in this case present to consciousness as muscular tensions, which are our symbols of forces in general. While no motion is produced they are felt to be equal, so far as the sensations can serve to measure equality; and when excess of tension is felt in the one arm, motion is experienced in the other. Here, as in the examples about to be given, the relation between cause and effect, though numerically indefinite, is definite in the respect that every additional increment of cause produces an additional increment of effect; and it is out of this and similar experiences that the idea of the relation of proportionality grows and becomes organic.

"A child, when biting his food, discovers that the harder he bites the deeper is the indentation; in other words, that the more force applied, the greater the effect. If he tears an object with his teeth, he finds that the more he pulls the more the thing yields. Let him press against something soft, as his own person, or his clothes, or a lump of clay, and he sees that the part or object pressed yields little or much, according to the amount of the muscular strain. He can bend a stick the more completely the more force he applies. Any elastic object, as a piece of india-rubber or a catapult, can be stretched the farther the harder he pulls. If he tries to push a small body, there is little resistance and it is easy to move; but he finds that a

big body presents greater resistance and is harder to move. The experience is precisely similar if he attempts to lift a big body and a little one; or if he raises a limb, with or without any object attached to it. He throws a stone: if it is light, little exertion propels it a considerable distance; if very heavy, great exertion only a short distance. So, also, if he jumps, a slight effort raises him to a short height, a greater effort to a greater height. By blowing with his mouth he sees that he can move small objects, or the surface of his morning's milk, gently or violently according as the blast is weak or strong. And it is the same with sounds: with a slight strain on the vocal organs he produces a murmur; with great strain he can raise a shout.

"The experiences these propositions record all implicate the same consciousness—the notion of proportionality between force applied and result produced; and it is out of this latent consciousness that the axiom of the perfect quantitative equivalence of the relations between cause and effect is evolved. To show how rigorous, how irreversible, this consciousness becomes, take a boy and suggest to him the following statements:—Can he not break a string he has, by pulling? tell him to double it, and then he will break it. He cannot bend or break a particular stick: let him make less effort and he will succeed. He is unable to raise a heavy weight: tell him he errs by using too much force. He can't push over a small chest: he will find it easier to upset a larger one. By blowing hard he cannot move a given object: if he blows lightly, he will move it. By great exertion he cannot make himself audible at a distance: but he will make himself heard with less exertion at a greater distance. Tell him to do all or any of these, and of course he fails. The propositions are unthinkable, and their unthinkableness shows that the consciousness which yields them is irreversible. These, then, are preconceptions, properly so called, which have

grown unconsciously out of the earliest experiences, beginning with those of the sucking infant, which are perpetually confirmed by fresh experiences, and which have at last become organized in the mental structure.

* * * * *

"Mr. Spencer's argument appears to be briefly this:—1. There are numberless experiences unconsciously acquired and unconsciously accumulated during the early life of the individual (in harmony with the acquisitions of all ancestral individuals) which yield the preconception, long anteceding anything like conscious physical experiments, that physical causes and effects vary together quantitatively. This is gained from all orders of physical experiences, and forms a universal preconception respecting them, which the physicist or other man of Science brings with him to his experiments.

"2. Mr. Spencer showed in three cases—chemical, physical, and mechanical—that this preconception, so brought, was tacitly involved in the conception which the experimenter drew from the results of his experiments.

"3. Having indicated this universal preconception, and illustrated its presence in these special conceptions, Mr. Spencer goes on to say that it is involved also in the special conception of the relation between force and motion, as formulated in the 'Second Law of Motion.' He asserts that this is simply one case out of the numberless cases in which all these consciously-reasoned conclusions rest upon the unconsciously-formed conclusions that precede reasoning. Mr. Spencer alleges that as it has become impossible for a boy to think that by a smaller effort he can jump higher, and for a shopman to think that smaller weights will outbalance greater quantities, and for the physicist to think that he will get increased effects from diminished causes, so it is impossible to think that 'alteration of motion' is not 'proportional to the motive force impressed.' And he maintains that this is, in fact, a

latent implication of unconsciously-organized experiences, just as much as those which the experimenter necessarily postulates."

To meet further misinterpretations, a second letter was written by Mr. Collier and published in *Nature* for June 4, 1874. The following are passages from it:—

"Having but limited space, and assuming that the requisite qualifications would be made by unbiased readers, I passed over all those details of the child's experiences which would have been required in a full exposition. Of course I was aware that in the bending of a stick the visible effect does not increase in the same ratio as the force applied; and hardly needed the 'Senior Wrangler' to tell me that the resistance to a body moving through a fluid increases in a higher ratio than the velocity. It was taken for granted that he, and those who think with him, would see that out of all these experiences, in some of which the causes and effects are simple, and in others of which they are complex, there grows the consciousness that the proportionality is the more distinct the simpler the antecedents and consequents. This is part of the preconception which the physicist brings with him and acts upon. Perhaps it is within the 'Senior Wrangler's' knowledge of physical exploration, that when the physicist finds a result not bearing that ratio to its assigned cause which the two were ascertained in other cases to have, he immediately assumes the presence of some perturbing cause or causes, which modify the ratio. There is, in fact, no physical determination made by any experimenter which does not assume, as an *a priori* necessity, that there cannot be a deviation from proportion without the presence of such additional cause.

"Returning to the general issue, perhaps the 'Senior Wrangler' will pay some respect to the judgment of one

who was a Senior Wrangler too, and a great deal more—who was distinguished not only as a mathematician but as an astronomer, a physicist, and also as an inquirer into the methods of science: I mean Sir John Herschel. In his *Discourse on the Study of Natural Philosophy*, he says:—

"'When we would lay down general rules for guiding and facilitating our search, among a great mass of assembled facts, for their common cause, we must have regard to the characters of that relation which we intend by cause and effect.'

"Of these 'characters' he sets down the third and fourth in the following terms:—

"'Increase or diminution of the effect, with the increased or diminished intensity of the cause, in cases which admit of increase and diminution.'

"'Proportionality of the effect to its cause in all cases of *direct unimpeded* action.'

"Observe that, in Sir J. Herschel's view, these are 'characters' of the relation of cause and effect to be accepted as 'general rules for *guiding* and facilitating our search' among physical phenomena—truths that must be taken for granted *before* the search, not truths derived *from* the search. Clearly, the 'proportionality of the effect to its cause in all cases of direct and unimpeded action' is here taken as *a priori*. Sir J. Herschel would, therefore, have asserted, with Mr. Spencer, that the Second Law of Motion is *a priori;* since this is one of the cases of the 'proportionality of the effect to its cause.'

"And now let the 'Senior Wrangler' do what Sir J. Herschel has not done or thought of doing—*prove* the proportionality of cause and effect. Neither he, nor any other of Mr. Spencer's opponents, has made the smallest attempt to deal with this main issue. Mr. Spencer alleges that this cognition of proportionality is *a priori:* not in the old sense, but in the sense that it grows out of experiences that precede reasoning. His opponents, following Prof. Tait in the assertion that Physics is a purely experimental science, containing, therefore, no *a priori* truths, affirm that this

cognition is *a posteriori*—a product of conscious induction. Let us hear what are the experiments. It is required to establish the truth that there is proportionality between causes and effects, *by a process which nowhere assumes* that if one unit of force produces a certain unit of effect, two units of such force will produce two units of such effect. Until the 'Senior Wrangler' has done this he has left Mr. Spencer's position untouched."

APPENDIX B.

[After publication of the letters from which the foregoing are reproduced, there appeared in *Nature* certain rejoinders containing misrepresentations even more extreme than those preceding them. There resulted a direct correspondence with two of the writers—Mr. Robert B. Hayward, of Harrow, and Mr. J. F. Moulton, my original assailant, the author of the article in the *British Quarterly Review*. This correspondence, in which I demanded from these gentlemen the justifications for their statements, formed part of this Appendix in its pamphlet form, as distributed among those who are competent to judge of the questions at issue. It is needless to give permanence to the replies and rejoinders. The character of Mr. Moulton's allegations, quite congruous with those I have exposed in the "Replies to Criticisms," may be inferred from one of the sentences closing my reply—"Wonderful to relate, my inductive proof that proportionality [of cause and effect] is taken for granted, he cites as my inductive proof of proportionality itself!" The result of the interchange of letters with Mr. Hayward, was to make it clear that "the thing I assert is not really disputed; and the thing disputed, I have nowhere asserted." While, however, the controversial part of the correspondence may fitly disappear,

I retain an expository part embodied in the following letter to Mr. Hayward.]

38, Queen's Gardens, Bayswater,
June 21st, 1874.

SIR,—Herewith I send you a copy of your letter with my interposed comments. I think those comments will make it clear to you that I have not committed myself to three different definitions of our consciousness of the Second Law of Motion.

As others may still feel a difficulty such as you seem to have felt, in understanding that which familiarity has made me regard as simple, I will endeavour, by a synthetic exposition, to make clear the way in which these later and more complex products of organized experiences stand related to earlier and simpler products. To make this exposition easier to follow, I will take first our Space-consciousness and the derived conceptions.

On the hypothesis of Evolution, the Space-consciousness results from organized motor, tactual, and visual experiences. In the *Principles of Psychology*, §§ 326—346, I have described in detail what I conceive to have been its genesis. Such Space-consciousness so generated, is one possessed in greater or less degree by all creatures of any intelligence; becoming wider, and more definite, according to the degree of mental evolution which converse with the environment has produced. How deeply registered the external relations have become in the internal structure, is shown by the facts that the decapitated frog pushes away with one or both legs the scalpel applied to the hind part of its body, and that the chick, as soon as it has recovered from the exhaustion of escaping from the egg, performs correctly-guided actions (accompanied by consciousness of distance and direction) in picking up grains. Ascending at once to such organized and inherited Space-consciousness as exists in the child, and which from moment to moment

it is making more complete by its own experiences (aiding the development of its nervous system into the finished type of the adult, by the same exercises which similarly aid the development of its muscular system), we have to observe that, along with increasingly-definite ideas of distance and direction, it gains unawares certain more special ideas of geometrical relations. Take one group of these. Every time it spreads open its fingers it sees increase of the angles between them, going along with increase of the distances between the finger-tips. In opening wide apart its own legs, and in seeing others walk, it has continually before it the relation between increase or decrease of base in a triangle having equal sides, and increase or decrease of the angle included by those sides. [The relation impressed on it being simply that of *concomitant variation*: I do not speak of any more definite relation, which, indeed, is unthinkable by the young.] It does not observe these facts in such way as to be conscious that it has observed them; but they are so impressed upon it as to establish a rigid association between certain mental states. Various of its activities disclose space-relations of this class more definitely. The drawing of a bow exhibits them in another way and with somewhat greater precision; and when, instead of the ends of a bow, capable of approaching one another, the points of attachment are fixed and the string elastic, the connexion between increasing length in the sides of an isosceles triangle and increasing acuteness of the included angle, is still more forced upon the attention; though it still does not rise into a conscious cognition. This is what I mean by an "unconsciously-formed preconception." When, in course of time, the child, growing into the boy, draws diagrams on paper, and, among other things, draws isosceles triangles, the truth that, the base being the same, the angle at the apex becomes more acute as the sides lengthen, is still more definitely displayed to him; and when his attention is drawn to this relation he finds that he

cannot think of it as being otherwise. If he imagines the lengths of the sides to change, he cannot exclude the consciousness of the correlative change in the angle; and presently, when his mental power is sufficiently developed, he perceives that if he continues to lengthen the sides in imagination, the lines approach parallelism as the angle approaches zero: yielding a conception of the relations of parallel lines. Here the consciousness has risen into the stage of definite conception. But, manifestly, the definite conception so reached is but a finishing of the preconceptions previously reached, and would have been impossible in their absence; and these unconsciously-formed preconceptions would similarly have been impossible in the absence of the still earlier consciousnesses of distance, direction relative position, embodied in the consciousness of Space. The whole evolution is one; the arrival at the distinct conception is the growing up to an ultimate definiteness and complexity; and it can no more be reached without passing through the earlier stages of indefinite consciousness, than the adult bodily structure can be reached without passing through the structures of the embryo, the infant, and the child.*

Through a parallel evolution arises, first the vague con-

* Here, in explaining the genesis of special space-intuitions, I have singled out a group of experiences which, in *Nature*, May 28, Mr. Hayward had chosen as illustrating the absurdity of supposing that the scientific conception of proportionality could be reached as alleged. He said:—

"It is hardly a parody of Mr. Collier's remarks to say:—'A child discovers that the greater the angle between his legs the greater the distance between his feet, an experience which implicates the notion of proportionality between the angle of a triangle and its opposite side;' a preconception, as it appears to me, with just as good a basis as that whose formation Mr. Collier illustrates, but one which, as I need hardly add, is soon corrected by a conscious study of geometry or by actual measurement."

I am indebted to Mr. Hayward for giving this instance. It conveniently serves two purposes. It serves to exemplify the connexion between the crude preconceptions unconsciously formed by earlier experiences, and the conceptions consciously evolved out of them by the help of later experiences, when the requisite powers of analysis and abstraction have been reached. And at the same time it serves to show the failure of my opponents to understand how, in the genesis of intelligence, the scientific conception of exact

sciousness of forces as exerted by self and surrounding things; presently, some discrimination in respect of their amounts as related to their effects; later, an association formed unawares between greatness of quantity in the two, and between smallness of quantity in the two; later still, a tacit assumption of proportionality, though without a distinct consciousness that the assumption has been made; and, finally, a rising of this assumption into definite recognition, as a truth necessarily holding where the forces are simple. Throughout its life every creature has, *within the actions of its moving parts*, forces and motions conforming to the Laws of Motion.

proportionality develops from the crude, vague, and inaccurate preconception. For while the notion of proportionality acquired by the child in Mr. Hayward's example, is not true, it is an approximation towards one which *is* true, and one which is reached when its more developed intelligence is brought critically to bear on the facts. Eventually it is discovered that the angle is not proportional to the subtending side, but to the subtending arc; and this is discovered *in the process of disentangling a simple relation from other relations which complicate and disguise it*. Between the angle and the arc there is exact proportionality, for the reason that only one set of directly-connected space-relations are concerned: the distance of the subtending arc from the subtended angle, remains constant—there is no change in the relation between the increasing angle and the increasing arc; and therefore the two vary together in direct proportion. But it is otherwise with the subtending side. The parts of this stand in different relations of distance from the subtended angle; and as the line is lengthened, each added part differs from the preceding parts in its distance from the angle. That is to say, one set of simple directly-connected geometrical relations, is here involved with another set; and the relation between the side and the angle is such that the law of relative increase involves the co-operation of two sets of factors. Now the distinguishing the true proportionality (between the angle and the arc) from the relation which simulates proportionality (between the angle and the side) is just that process of final development of exact conceptions, which I assert to be the finishing step of all the preceding development; and to be impossible in its absence. And the truth to which my assailants shut their eyes, is that, just as among these conceptions of space-relations, the conception of exact proportionality can be reached only by evolution from the crude notion of proportionality, formed before reasoning begins; so, among the force-relations, the conception of proportionality finally reached, when simple causes and their effects are disentangled by analytical intelligence, can be reached only by evolution of the crude notion of proportionality, established as a preconception by early experiences which reinforce ancestral experiences.

If it has a nervous system, the differences among the muscular tensions and the movements initiated, register themselves in a vague way in that nervous system. As the nervous system develops, along with more developed limbs, there are at once more numerous different experiences . . . of momentum generated, of connected actions and reactions (as when an animal tears the food which it holds with its paws); and, at the same time, there are, in its more developed nervous system, increased powers of appreciating and registering these differences. All the resulting connexions in consciousness, though unknowingly formed and unknowingly entertained, are ever present as guides to action: witness the proportion between the effort an animal makes and the distance it means to spring; or witness the delicate adjustments of muscular strains to changes of motion, made by a swallow catching flies or a hawk swooping on its quarry. Manifestly, then, these experiences, organized during the earlier stages of mental evolution, form a body of consciousnesses, not formulated into cognitions, nor present even as preconceptions, but nevertheless present as a mass of associations *in which the truths of relation between force and motion are potentially present.* On ascending to human beings of the uncultured sort, we reach a stage at which some nascent generalization of these experiences occur. The savage has not expressed to himself the truth that if he wants to propel his spear further he must use more force; nor does the rustic put into a distinct thought the truth that to raise double the weight he must put forth twice the effort; but in each there is a tacit assumption to this effect, as becomes manifest on calling it in question. So that, in respect of these and other simple mechanical actions, there exist unconsciously-formed preconceptions. And just as the geometrical truths presented in a rude way by the relations among surrounding objects, are not overtly recognized until there is some familiarity with straight lines, and diagrams made of them;

so, until linear measures, long used, have led to the equal-armed lever, or scales, and thus to the notion of equal units of force, this mechanical preconception cannot rise into definiteness. Nor after it has risen into definiteness does it for a long time reach the form of a consciously-held cognition; for neither the village huxter nor the more cultivated druggist in the town, recognizes the general abstract truth that, when uninterfered with, equi-multiples of causes and their effects are necessarily connected. But now observe that this truth, acted upon with more or less distinct consciousness of it by the man of science, and perfected by him through analysis and abstraction, is thus perfected only as the last step in its evolution. This definite cognition is but the finished form of a consciousness long in preparation—a consciousness the body of which is present in the brute, takes some shape in the primitive man, reaches greater definiteness in the semi-civilized, becomes afterwards an assumption distinct though not formulated, and takes its final development only as it rises into a consciously-accepted axiom. Just as there is a continuous evolution of the nervous system, so is there a continuous evolution of the consciousness accompanying its action. Just as the one grows in volume, complexity, and definiteness, so does the other. And just as necessary as the earlier stages are to the later in the one case, are they in the other. To suppose that the finished conceptions of science can exist without the unfinished common knowledge which precedes them, or this without still earlier mental acquisitions, is the same thing as to suppose that we can have the correct judgments of the adult without passing through the crude judgments of the youth, the narrow, incoherent ones of the child, and the vague, feeble ones of the infant. So far is it from being true that the view of physical axioms held by me, is one which bases cognitions on some other source than experience, it asserts experience to be the only possible source of these, as of other cognitions; but it asserts, further, that

not simply is the consciously-acquired experience of present actions needful, but that *for the very possibility of gaining this* we are indebted to the accumulated experiences of all past actions. Not I, but my antagonists, are really chargeable with accepting the ancient *a priori* view; since, without any explanation of them or justification of them, they posit as unquestionable the assumptions underlying every experiment and the conclusion drawn from it. The belief in physical causation, assumed from moment to moment as necessary in every experiment and in all reasoning from it, is a belief which, if not justified by the hypothesis above set forth, is tacitly asserted as an *a priori* belief. Contrariwise, my own position is one which affiliates all such beliefs upon experiences acquired during the whole past; which alleges those experiences as the only warrant for them; which asserts that during the converse between the mind and its environment, necessary connexions in Thought, such as those concerning Space, have resulted from infinite experiences of corresponding necessary connexions in Things; and that, similarly, out of perpetual converse with the Forces manifested to us in Space, there has been a progressive establishment of internal relations answering to external relations, in such wise that there finally emerge as physical axioms, certain necessities of Thought which answer to necessities in Things.

I need scarcely say that I have taken the trouble of making my comments on your letter, and of writing this further exposition, with a view to their ulterior use.

I am, &c.,

HERBERT SPENCER.

APPENDIX C.

SUMMARY OF RESULTS.

Those who deny a general doctrine enunciated by Mayer as the basis of his reasonings, habitually assumed by Faraday

as a guiding principle in drawing his conclusions, distinctly held by Helmholtz, and tacitly implied by Sir John Herschel —those, I say, who deny this general doctrine and even deride it, should be prepared with clear and strong reasons for doing this. Having been attacked, not in the most temperate manner, for enunciating this doctrine and its necessary implications in a specific form, I have demanded such reasons. Observe the responses to the demand.

1. The *British Quarterly* Reviewer quoted for my instruction the *dictum* of Professor Tait, that "Natural Philosophy is an experimental, and not an intuitive science. No *à priori* reasoning can conduct us demonstratively to a single physical truth." Thereupon I inquired what Professor Tait meant "by speaking of 'physical *axioms*,' and by saying that the cultured are enabled 'to see *at once* their *necessary* truth?'" ..... **No reply.**

2. Instead of an answer to the question, how this intuition of necessity can be alleged by Professor Tait consistently with his other doctrine, the Reviewer quotes, as though it disposed of my question, Professor Tait's statement that "as the properties of matter might have been such as to render a totally different set of laws axiomatic, *these laws* [of motion] *must be considered as resting on convictions drawn from observation and experiment, and not on intuitive perception.*" Whereupon I inquired how Professor Tait knows that "the properties of matter *might have been*" other

than they are. I asked how it happened that his intuition concerning things *as they are not*, is so certain that, by inference from it, he discredits our intuitions concerning things *as they are* ..... No reply: Professor Tait told, *à propos* of my question, a story of which no one could discover the application; but, otherwise, declined to answer. Nor was any answer given by his disciple.

3. Further, I asked how it happened that Professor Tait accepted as bases for Physics, Newton's Laws of Motion; which were illustrated but not *proved* by Newton, and of which no *proofs* are supplied by Professor Tait, in the *Treatise on Natural Philosophy*. I went on to examine what conceivable *a posteriori* warrant there can be if there is no warrant *a priori*; and I pointed out that neither from terrestrial nor from celestial phenomena can the First Law of Motion be deduced without a *petitio principii*..... No reply: the Reviewer characterized my reasoning as "utterly erroneous" (therein differing entirely from two emi-

nent authorities who read it in proof); but beyond so characterizing it he said nothing.

4. To my assertion that Newton gave no proof of the Laws of Motion, the Reviewer rejoined that "the whole of the *Principia* was the proof." On which my comment was that Newton called them "axioms," and that axioms are not commonly supposed to be proved by deductions from them.....

The Reviewer quotes from one of Newton's letters a passage showing that though he called the Laws of Motion "axioms," he regarded them as principles "made general by induction;" and that therefore he could not have regarded them as *a priori*.

5. In rejoinder, I pointed out that whatever conception Newton may have had of these "axioms," he explicitly and distinctly excluded them from the class of "hypotheses." Hence I inferred that he did not regard the whole of the

Principia as the proof, which the Reviewer says it is; since an assumption made at the outset, to be afterwards justified by the results of assuming it, is an "hypothesis"..... No reply.

6. Authority aside, I examined on its merits the assertion that the Laws of Motion are, or can be, proved true by the ascertained truth of astronomical predictions; and showed that the process of verification itself assumed those Laws. No reply.

7. To make still clearer the fact that ultimate physical truths are, and must be, accepted as *a priori*, I pointed out that in every experiment the physicist tacitly assumes a relation between cause and effect, such that, if one unit of cause produces its unit of effect, two units of the cause will produce two units of the effect; and I argued that this general assumption included the special assumption asserted in the Second Law of Motion. No reply: that is to say, no endeavour to show the untruth of this statement, but a quibble based on my omission of the word "proportionality" in places where it was implied, though not stated.

8. Attention was drawn to a passage

from Sir John Herschel's *Discourse on the Study of Natural Philosophy*, in which the "proportionality of the effect to its cause in all cases of *direct unimpeded* action" is included by him among "the characters of that relation which we intend by cause and effect;" and in which this assumption of proportionality is set down as one *preceding* physical exploration, and not as one to be established by it ..... **No reply.**

9. Lastly, a challenge to prove this proportionality. "It is required to establish the truth that there is proportionality between causes and effects, *by a process which nowhere assumes* that if one unit of force produces a certain unit of effect, two units of such force will produce two units of such effect." ..... **No reply.**

Thus on all these essential points my three mathematical opponents allow judgment to go against them by default. The attention of readers has been drawn off from the main issues by the discussion of side issues. Fundamental questions have been evaded, and new questions of subordinate kinds raised.

What is the implication? One who is able to reach and to carry the central position of his antagonist, does not spend his strength on small outposts. If he declines to assault the stronghold, it must be because he sees it to be impregnable.

The trouble I have thus taken to meet criticisms and dissipate misapprehensions, I have taken because the attack

made on the special doctrine defended, is part of an attack on the ultimate doctrine underlying the deductive part of *First Principles*—the doctrine that the quantity of existence is unchangeable. I agree with Sir W. Hamilton that our consciousness of the necessity of causation, results from the impossibility of conceiving the totality of Being to increase or decrease. The proportionality of cause and effect is an implication: denial of it involves the assertion that some quantity of cause has disappeared without effect, or some quantity of effect has arisen without cause. I have asserted the *a priori* character of the Second Law of Motion, *under the abstract form in which it is expressed*, simply because this, too, is an implication, somewhat more remote, of the same ultimate truth. And my sole reason for insisting on the validity of these intuitions, is that, on the hypothesis of Evolution, absolute uniformities in things have produced absolute uniformities in thoughts; and that necessary thoughts represent infinitely-larger accumulations of experiences than are formed by the observations, experiments, and reasonings of any single life.

PROF. GREEN'S EXPLANATIONS.

[*From the* Contemporary Review *for Feb.* 1881. *It would not have occurred to me to reproduce this essay, had it not been that there has lately been a reproduction of the essay to which it replies. But as Mr. Nettleship, in his editorial capacity, has given a permanent shape to Professor Green's unscrupulous criticism, I am obliged to give a permanent shape to the pages which show its unscrupulousness.*]

DREARY at best, metaphysical controversy becomes especially dreary when it runs into rejoinders and re-rejoinders; and hence I feel some hesitation in inflicting, even upon those readers of the *Contemporary* who are interested in metaphysical questions, anything further concerning Prof. Green's criticism, Mr. Hodgson's reply to it, and Prof. Green's explanations. Still, it appears to me that I can now hardly let the matter pass without saying something in justification of the views attacked by Prof. Green; or, rather, in disproof of the allegations he makes against them.

I did not, when Prof. Green's two articles appeared, think it needful to notice them: my wish to avoid hindrance to my work, being supported partly by the thought that very few would read a discussion so difficult to follow, and partly by the thought that, of the few who did read it, most would be those whose knowledge of *The Principles of Psychology* enabled them to see how unlike the argument

I have used is the representation of it given by Prof. Green, and how inapplicable his animadversions therefore are. This last belief was, I find, quite erroneous; and I ought to have known better than to form it. Experience might have shown me that readers habitually assume a critic's version of an author's statement to be the true version, and that they rarely take the trouble to see whether the meaning ascribed to a detached passage is the meaning which it bears when taken with the context. Moreover, I should have remembered that in the absence of disproofs it is habitually assumed that criticisms are valid; and that inability rather than pre-occupation prevents the author from replying. I ought not, therefore, to have been surprised to learn, as I did from the first paragraph of Mr. Hodgson's article, that Prof. Green's criticisms had met with considerable acceptance.

I am much indebted to Mr. Hodgson for undertaking the defence of my views; and after reading Prof. Green's rejoinder, it seems to me that Mr. Hodgson's chief allegations remain outstanding. I cannot here, of course, follow the controversy point by point. I propose to deal simply with the main issues.

At the close of his answer, Prof. Green refers to "two other misapprehensions of a more general nature, which he [Mr. Hodgson] alleges against me at the outset of his article." Not admitting these, Prof. Green postpones replies for the present; though by what replies he can show his apprehensions to be true ones, I do not see. Further misapprehensions of a general nature, which stand as preliminaries to his criticisms, may here be instanced, as serving, I think, to show that those criticisms are misdirected.

From *The Principles of Psychology* Prof. Green quotes the following sentences:—

"The relation between these, as antithetically opposed divisions of the

entire assemblage of manifestations of the Unknowable, was our datum The fabric of conclusions built upon it must be unstable if this datum can be proved either untrue or doubtful. Should the idealist be right, the doctrine of evolution is a dream."

And on these sentences he comments thus :—

"To those who have humbly accepted the doctrine of evolution as a valuable formulation of our knowledge of animal life, but at the same time think of themselves as 'idealists,' this statement may at first cause some uneasiness. On examination, however, they will find in the first place that when Mr. Spencer in such a connection speaks of the doctrine of evolution, he is thinking chiefly of its application to the explanation of knowledge—an application at least not necessarily admitted in the acceptance of it as a theory of animal life."*

From which it appears that Prof. Green's conception of Evolution is that popular conception in which it is identified with that set forth in *The Origin of Species*. That my conception of Evolution, referred to in the passage he quotes, is a widely different one, would have been perceived by him had he referred to the exposition of it contained in *First Principles*. My meaning in the passage he quotes is, that since Evolution, as I conceive it, is, under certain conditions, the result of that universal redistribution of matter and motion which is, and ever has been, going on; and since, during those phases of it which are distinguishable as astronomic and geologic, the implication is that no life, still less consciousness (under any such form as is known to us), existed; there is necessarily implied by the theory of Evolution, a mode of Being independent of, and antecedent to, the mode of Being we now call consciousness. And I implied that, consequently, this theory must be a dream, if either ideas are the only existences, or if, as Prof. Green appears to think, the object exists only by correlation with the subject. How necessary is this more general view as a basis for my psychological view, and how erroneous is a criticism which ignores it, will be seen on observing that by ignoring it, I am made to appear profoundly inconsistent where other-

* *Contemporary Review*, December, 1877, p. 35.

wise there is no inconsistency. Prof. Green says that my doctrine—

"ascribes to the object, which in truth is nothing without the subject, an independent reality, and then supposes it gradually to produce certain qualities in the subject, of which the existence is in truth necessary to the possibility of those qualities in the object which are supposed to produce them."*

On which my comment is that, ascribing, as I do, "an independent reality" to the object, and denying that the object is "nothing without the subject," my doctrine, though wholly inconsistent with that of Professor Green, is wholly consistent with itself. Had he rightly conceived the doctrine of Transfigured Realism (*Prin. of Psy.* § 473), Prof. Green would have seen that while I hold that the qualities of object and subject, as present to consciousness, being resultants of the co-operation of object and subject, exist only through their co-operation, and, in common with all resultants, must be unlike their factors; yet that there pre-exist those factors, and that without them no resultants can exist.

Equally fundamental is another preliminary misconception which Prof. Green exhibits. He says—

"We should be sorry to believe that Mr. Spencer and Mr. Lewes regard the relation between consciousness and the world as corresponding to that between two bodies, of which one is inside the other; but apart from some such crude imagination it does not appear, &c."

Now since I deliberately accept, and have expounded at great length, this view which Professor Green does not ascribe to me, because he would be "sorry to believe" I entertain such a "crude imagination"—since this view is everywhere posited by the doctrine of Psychological Evolution as I have set it forth; I am astonished at finding it supposed that I hold some other view. Considering that Parts II. III. and IV. of the *Principles of Psychology* are occupied with tracing out mental Evolution as a result of converse between organism and environment; and con-

* *Contemporary Review*, December, 1877, p. 87.

sidering that throughout Part V. the interpretations, analytical instead of synthetical, pre-suppose from moment to moment a surrounding world and an included organism; I cannot imagine a stranger assumption than that I do not believe the relationship between consciousness and the world to be that of inclusion of the one by the other. I am aware that Prof. Green does not regard me as a coherent thinker; but I scarcely expected he would ascribe to me an incoherence so extreme that in Part VI. I abandon the fundamental assumption on which all the preceding parts stand, and adopt some other. And I should the less have expected so extreme an incoherence to be ascribed to me, considering that throughout Part VI. this same belief is tacitly implied as part of that realistic belief which it is the aim of its argument to explain and justify. Here, however, the fact of chief significance is, that as Professor Green would be "sorry to believe" I hold the view named, and refrains from ascribing to me so "crude an imagination," it is to be concluded that his arguments are directed against some other view which he supposes me to hold. If so, one of two conclusions is inevitable. Either his criticisms are valid against this other view which he tacitly ascribes to me, or they are not. If he admits them to be invalid on the assumption that I hold this other view, the matter ends. If he holds them to be valid on the assumption that I hold this other view, then they must be invalid against the absolutely-different view which I actually hold; and again the matter ends.

Even were I to leave off here, I might, I think, say that the inapplicability of Prof. Green's arguments is sufficiently shown; but it may be desirable to point out that beyond these general misapprehensions, by which they are vitiated, there are special misapprehensions. Much to my surprise, considering the careful preliminary explanation I have given, he has failed to understand the mental attitude assumed by me when describing the synthesis of experiences

against which he more especially urges his objections. In chapters entitled "Partial Differentiation of Subject and Object," "Completed Differentiation of Subject and Object," and "Developed Conception of the Object," I have endeavoured, as these titles imply, to trace up the gradual establishment of this fundamental antithesis in a developing intelligence. It appeared to me, and still appears, that for coherent thinking there must be excluded at the outset, not only whatever implies acquired knowledge of objective existence, but also whatever implies acquired knowledge of subjective existence. At the close of the chapter preceding those just named, as well as in *First Principles*, where this process of differentiation was more briefly indicated, I recognized, and emphatically enlarged upon, the difficulty of carrying out such an inquiry: pointing out that in any attempts we make to observe the way in which subject and object become distinguished, we inevitably use those faculties and conceptions which have grown up while the differentiation of the two has been going on. In trying to discern the initial stages of the process, we carry with us all the products which belong to the final stage, and cannot free ourselves from them. In *First Principles* (§ 43) I have pointed out that the words *impressions* and *ideas*, the term *sensation*, the phrase *state of consciousness*, severally involve large systems of beliefs; and that if we allow ourselves to recognize their connotations we inevitably reason circularly. And in the closing sentence of the chapter preceding those above named, I have said—

"Though in every illustration taken we shall have tacitly to posit an external existence, and in every reference to states of consciousness we shall have to posit an internal existence which has these states; yet, as before, we must ignore these implications."

I should have thought that, with all these cautions before him, Prof. Green would not have fallen into the error of supposing that in the argument thereupon commenced, the phrase "states of consciousness" is used with all its ordinary implications. I should have thought that, as in

a note appended to the outset of the argument I have referred to the parallel argument in *First Principles*, where I have used the phrase "manifestations of existence" instead of "states of consciousness," as the least objectionable; and as the argument in the *Psychology* is definitely described in this note as a re-statement in a different form of the argument in *First Principles;* he would have seen that in the phrase "states of consciousness," as used throughout this chapter, was to be included no more meaning than was included in the phrase "manifestations of existence."* I should have thought he would have seen that the purpose of the chapter was passively to watch, with no greater intelligence than is implied in watching, how the manifestations or states, vivid and faint, comport themselves: excluding all thought of their meanings—all interpretations of them. Nevertheless, Prof. Green charges me with having, at the outset of the examination, invalidated my argument by implying, in the terms I use, certain products of developed consciousness.† He contends that my division of the "states of consciousness," or, as I elsewhere term them, "manifestations of existence," into vivid and faint, is vitiated from the first by including along with the vivid ones those faint ones needful to constitute them perceptions, in the ordinary sense of the word. Because, describing all I passively watch, I speak of a distant head-

* If I am asked why here I used the phrase "states of consciousness" rather than "manifestations of existence," though I had previously preferred the last to the first, I give as my reason the desire to maintain continuity of language with the preceding chapter, "The Dynamics of Consciousness." In that chapter an examination of consciousness had been made with the view of ascertaining what principle of cohesion determines our beliefs, as preliminary to observing how this principle operates in establishing the beliefs in subject and object. But on proceeding to do this, the phrase "state of consciousness" was supposed, like the phrase "manifestation of existence," not to be used as anything more than a name by which to distinguish this or that form of being, as an undeveloped receptivity would become aware of it, while yet self and not-self were undistinguished.

† *Contemporary Review*, December, 1877, pp. 49, 50.

land, of waves, of boats, &c., he actually supposes me to be speaking of those developed cognitions under which these are classed as such and such objects. What would he have me do? It is impossible to give any such account of the process as I have attempted, without using names for things and actions. The various manifestations, vivid and faint, which in the case described impose themselves on my receptivity, must be indicated in some way; and the words indicating them inevitably carry with them their respective connotations. What more can I do than warn the reader that all these connotations must be ignored, and that attention must be paid exclusively to the manifestations themselves, and the modes in which they comport themselves. At the stage described in this "partial differentiation," while I suppose myself as yet unconscious of my own individuality and of a world as separate from it, the obvious implication is, that what I name "states of consciousness," because this is the current term for them, are to have no interpretations whatever put upon them; but that their characters and modes of behaviour are to be observed, as they might be while yet there had been none of that organization of experiences which makes things known in the ordinary sense. It is true that, thus misinterpreting me in December, Prof. Green, writing again in March, puts into the mouth of an imagined advocate the true statement of my view;* though he (Prof. Green) then proceeds to deny that I can mean what this imagined advocate rightly says I mean: taking occasion to allege that I use the phrase "states of consciousness" "to give a philosophical character" to what would else seem "written too much after the fashion of a newspaper correspondent."† Even, however, had he admitted that intended meaning which he sees, but denies, the rectification would have been somewhat unsatisfactory, coming three months after various

* *Contemporary Review*, March, 1878, p. 758.

† *Ibid.*, March, 1878, p. 755.

absurdities, based on his misinterpretation, had been ascribed to me.

But the most serious allegation made by Mr. Hodgson against Prof. Green, and which I here repeat, is that he habitually says I regard the object as constituted by "the aggregate of vivid states of consciousness," in face of the conspicuous fact that I identify the object with the *nexus* of this aggregate. In his defence Prof. Green says—

"If I had made any attempt to show that Mr. Spencer believes the object to be no more than an aggregate of vivid states of consciousness, Mr. Hodgson's complaint, that I ignore certain passages in which a contrary persuasion is stated, would have been to the purpose."

Let us look at the facts. Treating of the relation between my view and the idealistic and sceptical views, he imagines addresses made to me by Berkeley and Hume. "'You agree with me,' Berkeley might say, 'that when we speak of the external world we are speaking of certain lively ideas connected in a certain manner;'"* and this identification of the world with ideas, I am tacitly represented as accepting. Again, Hume is supposed to say to me—"You agree with me that what we call the world is a series of impressions;"† and here, as before, I am supposed silently to acquiesce in this as a true statement of my view. Similarly throughout his argument, Prof. Green continually states or implies that the object is, in my belief, constituted by the vivid aggregate of states of consciousness. At the outset of his second article,‡ he says of me:—"He there" [in the *Principles of Psychology*] "identifies the object with a certain aggregate of vivid states of consciousness, which he makes out to be independent of another aggregate, consisting of faint states, and identified with the subject." And admitting that he thus describes my view, he nevertheless alleges that he does not misrepresent me, because, as he says,§ "there is scarcely a page of my article in

* *Contemporary Review*, December, 1877, p. 44.

† *Ibid.*, December, 1877, p. 44.

‡ *Ibid.*, March, 1878, p. 745.

§ *Ibid.*, January, 1881, p. 115.

which Mr. Spencer's conviction of the externality and independence of the object, in the various forms in which it is stated by him, is not referred to." But what if it is referred to in the process of showing that the externality and independence of the object is utterly inconsistent with the conception of it as an aggregate of vivid states of consciousness? What if I am continually made to seem thus absolutely inconsistent, by omitting the fact that not the aggregate of vivid states itself is conceived by me as the object, but the *nexus* binding it together?

A single brief example will typify Prof. Green's general method of procedure. On page 40 of his first article he says—"And in the sequel the 'separation of themselves' on the part of states of consciousness 'into two great aggregates, vivid and faint,' is spoken of as a 'differentiation between the antithetical existences we call object and subject.' If words mean anything, then, Mr. Spencer plainly makes the 'object' an aggregate of conscious states." But in the entire passage from which these words of mine are quoted, which he gives at the bottom of the page, a careful reader will observe a word (*omitted* from Prof. Green's quotation in the text), which quite changes the meaning. I have described the result, not as "a differentiation," but as "a *partial* differentiation." Now, to use Prof. Green's expression, "if words mean anything," a partial differentiation cannot have the same sense as a complete differentiation. If the 'object' has been already constituted by this partial differentiation, what does the 'object' become when the differentiation is completed? Clearly, "if words mean anything," then, had Prof. Green not omitted the word "partial," it would have been manifest that the aggregate of vivid states was *not* alleged to be the object. The mode of treatment which we here see in little, exemplifies Prof. Green's mode of treatment at large. Throughout his two articles he criticizes detached portions, and ascribes to them meanings

quite different from those which they have when joined with the rest.

With the simplicity of "a raw undergraduate" (to some of whose views Prof. Green compares some of mine) I had assumed that an argument running through three chapters would not be supposed to have its conclusion expressed in the first; but now, after the professorial lesson I have received, my simplicity will be decreased, and I shall be aware that a critic may deal with that which is avowedly partial, as though it were entire, and may treat as though it were already developed, a conception which the titles of the chapters before him show is yet but incipient.

Here I leave the matter, and if anything more is said, shall let it pass. Controversy must be cut short, or work must be left undone. I can but suggest that metaphysical readers will do well to make their own interpretations of my views, rather than to accept without inquiry all the interpretations offered them.

POSTSCRIPT.—From a note appended by Mr. Nettleship to his republished versions of Prof. Green's articles, it appears that, after the foregoing pages were published by me, Prof. Green wrote to the editor of the *Contemporary Review*, saying:—

"While I cannot honestly retract anything in the substance of what I then wrote, there are expressions in the article which I very much regret, so far as they might be taken to imply want of personal respect for Mr. Spencer. For reasons sufficiently given in my reply to Mr. Hodgson, I cannot plead guilty to the charge of misrepresentation which Mr. Spencer repeats; but on reading my first article again in cold blood I found that I had allowed controversial heat to betray me into the use of language which was unbecoming —especially on the part of an unknown writer (not even then a 'professor') assailing a veteran philosopher. I make this acknowledgment merely for my own satisfaction, not under the impression that it can at all concern Mr. Spencer" (vol. i., p. 541).

Possibly some of Prof. Green's adherents will ask how, after he has stated that he cannot honestly retract, and that

he is not guilty of misrepresentation, I can describe his criticism as unscrupulous. My reply is that a critic who persists in saying that which, on the face of it, is dishonest, and then avers that he cannot honestly do otherwise, does not thereby prove his honesty, but contrariwise. One who deliberately omits from his quotation the word "partial," and then treats, as though it were complete, that which is avowedly incomplete—one who, in dealing with an argument which runs through three chapters, recognises only the first of them—one who persists in thinking it proper to do this after the consequent distortions of statement have been pointed out to him; is one who, if not knowingly dishonest, is lacking in due perception of right and wrong in controversy. The only other possible supposition which occurs to me, is that such a proceeding is a natural sequence of the philosophy to which he adheres. Of course, if Being and non-Being are the same, then representation and misrepresentation are the same.

I may add that there is a curious kinship between the ideas implied by the letter above quoted and its implied sentiments. Prof. Green says that his apology for unbecoming language he makes merely for his "own satisfaction." He does not calm his qualms of conscience by indicating his regret to those who read this unbecoming language; nor does he express his regret to me, against whom it was vented; but he expresses his regret to the editor of the *Contemporary Review!* So that a public insult to A is supposed to be cancelled by a private apology to B! Here is more Hegelian thinking; or rather, here is Hegelian feeling congruous with Hegelian thinking.

THE PHILOSOPHY OF STYLE.

[*First published in* The Westminster Review *for October* 1852.]

COMMENTING on the seeming incongruity between his father's argumentative powers and his ignorance of formal logic, Tristram Shandy says:—"It was a matter of just wonder with my worthy tutor, and two or three fellows of that learned society, that a man who knew not so much as the names of his tools, should be able to work after that fashion with them." Sterne's implied conclusion that a knowledge of the principles of reasoning neither makes, nor is essential to, a good reasoner, is doubtless true. Thus, too, is it with grammar. As Dr. Latham, condemning the usual school-drill in Lindley Murray, rightly remarks:—"Gross vulgarity is a fault to be prevented; but the proper prevention is to be got from habit—not rules." Similarly, good composition is far less dependent on acquaintance with its laws, than on practice and natural aptitude. A clear head, a quick imagination, and a sensitive ear, will go far towards making all rhetorical precepts needless. And where there exists any mental flaw—where there is a deficient verbal memory, or an inadequate sense of logical dependence, or but little perception of order, or a lack of constructive ingenuity; no amount of instruction will insure good writing. Nevertheless, *some* result may be expected from a familiarity

with the principles of style. The endeavour to conform to laws may tell, though slowly. And if in no other way, yet, as facilitating revision, a knowledge of the thing to be achieved—a clear idea of what constitutes a beauty, and what a blemish—cannot fail to be of service.

No general theory of expression seems yet to have been enunciated. The maxims contained in works on composition and rhetoric, are presented in an unorganized form. Standing as isolated dogmas—as empirical generalizations, they are neither so clearly apprehended, nor so much respected, as they would be were they deduced from some simple first principle. We are told that "brevity is the soul of wit." We hear styles condemned as verbose or involved. Blair says that every needless part of a sentence "interrupts the description and clogs the image;" and again, that "long sentences fatigue the reader's attention." It is remarked by Lord Kaimes that, "to give the utmost force to a period, it ought, if possible, to be closed with the word that makes the greatest figure." Avoidance of parentheses, and the use of Saxon words in preference to those of Latin origin, are often insisted upon. But, however influential the precepts thus dogmatically expressed, they would be much more influential if reduced to something like scientific ordination. In this as in other cases, conviction is strengthened when we understand the *why*. And we may be sure that recognition of the general principle from which the rules of composition result, will not only bring them home to us with greater force, but will disclose other rules of like origin.

On seeking for some clue to the law underlying these current maxims, we may see implied in many of them, the importance of economizing the reader's or hearer's attention. To so present ideas that they may be apprehended with the least possible mental effort, is the desideratum towards which most of the rules above quoted point. When we

condemn writing that is wordy, or confused, or intricate—when we praise this style as easy, and blame that as fatiguing, we consciously or unconsciously assume this desideratum as our standard of judgment. Regarding language as an apparatus of symbols for conveying thought, we may say that, as in a mechanical apparatus, the more simple and the better arranged its parts, the greater will be the effect produced. In either case, whatever force is absorbed by the machine is deducted from the result. A reader or listener has at each moment but a limited amount of mental power available. To recognize and interpret the symbols presented to him, requires part of this power; to arrange and combine the images suggested by them requires a further part; and only that part which remains can be used for framing the thought expressed. Hence, the more time and attention it takes to receive and understand each sentence, the less time and attention can be given to the contained idea; and the less vividly will that idea be conceived. How truly language must be regarded as a hindrance to thought, though the necessary instrument of it, we shall clearly perceive on remembering the comparative force with which simple ideas are communicated by signs. To say, "Leave the room," is less expressive than to point to the door. Placing a finger on the lips is more forcible than whispering, "Do not speak." A beck of the hand is better than, "Come here." No phrase can convey the idea of surprise so vividly as opening the eyes and raising the eyebrows. A shrug of the shoulders would lose much by translation into words. Again, it may be remarked that when oral language is employed, the strongest effects are produced by interjections, which condense entire sentences into syllables. And in other cases, where custom allows us to express thoughts by single words, as in *Beware*, *Heigho*, *Fudge*, much force would be lost by expanding them into specific propositions. Hence, carrying out the metaphor that

language is the vehicle of thought, we may say that in all cases the friction and inertia of the vehicle deduct from its efficiency; and that in composition, the chief thing to be done, is, to reduce the friction and inertia to the smallest amounts. Let us then inquire whether economy of the recipient's attention is not the secret of effect, alike in the right choice and collocation of words, in the best arrangement of clauses in a sentence, in the proper order of its principal and subordinate propositions, in the judicious use of simile, metaphor, and other figures of speech, and even in the rhythmical sequence of syllables.

The greater forcibleness of Saxon English, or rather non-Latin English, first claims our attention. The several special reasons assignable for this may all be reduced to the general reason—economy. The most important of them is early association. A child's vocabulary is almost wholly Saxon. He says, *I have*, not *I possess*—*I wish*, not *I desire*; he does not *reflect*, he *thinks*; he does not beg for *amusement*, but for *play*; he calls things *nice* or *nasty*, not *pleasant* or *disagreeable*. The synonyms learned in after years, never become so closely, so organically, connected with the ideas signified, as do these original words used in childhood; the association remains less strong. But in what does a strong association between a word and an idea differ from a weak one? Essentially in the greater ease and rapidity of the suggestive action. Both of two words, if they be strictly synonymous, eventually call up the same image. The expression—It is *acid*, must in the end give rise to the same thought as—It is *sour*; but because the term *acid* was learnt later in life, and has not been so often followed by the ideal sensation symbolized, it does not so readily arouse that ideal sensation as the term *sour*. If we remember how slowly the meanings follow unfamiliar words in another language, and how increasing familiarity with them brings greater rapidity and ease of comprehension; and if we consider that the

like effect must have resulted from using the words of our mother tongue from childhood upwards; we shall clearly see that the earliest learnt and oftenest used words, will, other things equal, call up images with less loss of time and energy than their later learnt equivalents.

The further superiority possessed by Saxon English in its comparative brevity, obviously comes under the same generalization. If it be an advantage to express an idea in the smallest number of words, then it must be an advantage to express it in the smallest number of syllables. If circuitous phrases and needless expletives distract the attention and diminish the strength of the impression produced, then so, too, must surplus articulations. A certain effort, though commonly an inappreciable one, is required to recognize every vowel and consonant. If, as all know, it is tiresome to listen to an indistinct speaker, or to read an ill-written manuscript; and if, as we cannot doubt, the fatigue is a cumulative result of the attention needed to catch successive syllables; it follows that attention is in such cases absorbed by each syllable. And this being so when the syllables are difficult of recognition, it will be so too, though in a less degree, when the recognition of them is easy. Hence, the shortness of Saxon words becomes a reason for their greater force. One qualification, however, must not be overlooked. A word which embodies the most important part of the idea to be conveyed, especially when emotion is to be produced, may often with advantage be a polysyllabic word. Thus it seems more forcible to say —"It is *magnificent*," than—"It is *grand*." The word *vast* is not so powerful a one as *stupendous*. Calling a thing *nasty* is not so effective as calling it *disgusting*. There seem to be several causes for this exceptional superiority of certain long words. We may ascribe it partly to the fact that a voluminous, mouth-filling epithet is, by its very size, suggestive of largeness or strength, as is shown by the pomposity of sesquipedalian verbiage; and when great power or

intensity has to be suggested, this association of ideas aids the effect. A further cause may be that a word of several syllables admits of more emphatic articulation; and as emphatic articulation is a sign of emotion, the unusual impressiveness of the thing named is implied by it. Yet another cause is that a long word (of which the latter syllables are generally inferred as soon as the first are spoken) allows the hearer's consciousness more time to dwell on the quality predicated; and where, as in the above cases, it is to this predicated quality that the entire attention is called, an advantage results from keeping it before the mind for an appreciable interval. To make our generalization quite correct we must therefore say, that while in certain sentences expressing feeling, the word which more especially implies that feeling may often with advantage be a many-syllabled one; in the immense majority of cases, each word, serving but as a step to the idea embodied by the whole sentence, should, if possible, be a single syllable.

Once more, that frequent cause of strength in Saxon and other primitive words—their onomatopœia, may be similarly resolved into the more general cause. Both those directly imitative, as *splash, bang, whiz, roar,* &c., and those analogically imitative, as *rough, smooth, keen, blunt, thin, hard, crag,* &c., have a greater or less likeness to the things symbolized; and by making on the ears impressions allied to the ideas to be called up, they save part of the effort needed to call up such ideas, and leave more attention for the ideas themselves.

Economy of the recipient's mental energy may be assigned, too, as a manifest cause for the superiority of specific over generic words. That concrete terms produce more vivid impressions than abstract ones, and should, when possible, be used instead, is a current maxim of composition. As Dr. Campbell says, "The more general the terms are, the picture is the fainter; the more special

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they are, the brighter." When aiming at effect we should avoid such a sentence as:

—— When the manners, customs, and amusements of a nation are cruel and barbarous, the regulations of their penal code will be severe.

And in place of it we should write:

—— When men delight in battles, bull-fights, and combats of gladiators, will they punish by hanging, burning, and the rack.

This superiority of specific expressions is clearly due to a saving of the effort required to translate words into thoughts. As we do not think in generals but in particulars—as, whenever any class of things is named, we represent it to ourselves by calling to mind individual members of the class; it follows that when a general word is used, the hearer or reader has to choose from his stock of images, one or more, by which he may figure to himself the whole group. In doing this, some delay must arise—some force be expended; and if, by employing a specific term, an appropriate image can be at once suggested, an economy is achieved, and a more vivid impression produced.

Turning now from the choice of words to their sequence, we find the same principle hold good. We have *a priori* reasons for believing that there is some one order of words by which every proposition may be more effectively expressed than by any other; and that this order is the one which presents the elements of the proposition in the succession in which they may be most readily put together. As in a narrative, the events should be stated in such sequence that the mind may not have to go backwards and forwards in order to rightly connect them; as in a group of sentences, the arrangement should be such that each of them may be understood as it comes, without waiting for subsequent ones; so in every sentence, the sequence of words should be that which suggests the constituents of the thought in the order most convenient for building it

up. Duly to enforce this truth, and to prepare the way for applications of it, we must analyze the mental act by which the meaning of a series of words is apprehended.

We cannot more simply do this than by considering the proper collocation of substantive and adjective. Is it better to place the adjective before the substantive, or the substantive before the adjective? Ought we to say with the French—*un cheval noir;* or to say as we do—a black horse? Probably, most persons of culture will say that one order is as good as the other. Alive to the bias produced by habit, they will ascribe to that the preference they feel for our own form of expression. They will expect those educated in the use of the opposite form to have an equal preference for that. And thus they will conclude that neither of these instinctive judgments is of any worth. There is, however, a psychological ground for deciding in favour of the English custom. If "a horse black" be the arrangement, then immediately on the utterance of the word "horse," there arises, or tends to arise, in the mind, an idea answering to that word; and as there has been nothing to indicate what *kind* of horse, any image of a horse suggests itself. Very likely, however, the image will be that of a brown horse: brown horses being the most familiar. The result is that when the word "black" is added, a check is given to the process of thought. Either the picture of a brown horse already present to the imagination has to be suppressed, and the picture of a black one summoned in its place; or else, if the picture of a brown horse be yet unformed, the tendency to form it has to be stopped. Whichever is the case, some hindrance results. But if, on the other hand, "a black horse" be the expression used, no mistake can be made. The word "black," indicating an abstract quality, arouses no definite idea. It simply prepares the mind for conceiving some object of that colour; and the attention is kept suspended until that object is known. If, then, by pre-

cedence of the adjective, the idea is always conveyed rightly, whereas precedence of the substantive is apt to produce a misconception; it follows that the one gives the mind less trouble than the other, and is therefore more forcible.

Possibly it will be objected that the adjective and substantive come so close together, that practically they may be considered as uttered at the same moment; and that on hearing the phrase, "a horse black," there is not time to imagine a wrongly coloured horse before the word "black" follows to prevent it. It must be owned that it is not easy to decide by introspection whether this is so or not. But there are facts collaterally implying that it is not. Our ability to anticipate the words yet unspoken is one of them. If the ideas of the hearer lingered behind the expressions of the speaker, as the objection assumes, he could hardly foresee the end of a sentence by the time it was half delivered; yet this constantly happens. Were the supposition true, the mind, instead of anticipating, would fall more and more in arrear. If the meanings of words are not realized as fast as the words are uttered, then the loss of time over each word must entail an accumulation of delays and leave a hearer entirely behind. But whether the force of these replies be or be not admitted, it will scarcely be denied that the right formation of a picture must be facilitated by presenting its elements in the order in which they are wanted; even though the mind should do nothing until it has received them all.

What is here said respecting the succession of the adjective and substantive is applicable, by change of terms, to the adverb and verb. And without further explanation, it will be manifest, that in the use of prepositions and other particles, most languages spontaneously conform with more or less completeness to this law.

On similarly analyzing sentences considered as vehicles for entire propositions, we find not only that the same principle holds good, but that the advantage of respecting

it becomes marked. In the arrangement of predicate and subject, for example, we are at once shown that as the predicate determines the aspect under which the subject is to be conceived, it should be placed first; and the striking effect produced by so placing it becomes comprehensible. Take the often-quoted contrast between—"Great is Diana of the Ephesians," and—"Diana of the Ephesians is great." When the first arrangement is used, the utterance of the word "great," arousing vague associations of an imposing nature prepares the imagination to clothe with high attributes whatever follows; and when the words, "Diana of the Ephesians" are heard, appropriate imagery already nascent in thought, is used in the formation of the picture: the mind being thus led directly, and without error, to the intended impression. But when the reverse order is followed, the idea, "Diana of the Ephesians," is formed with no special reference to greatness; and when the words, "is great," are added, it has to be formed afresh; whence arises a loss of mental energy, and a corresponding diminution of effect. The following verse from Coleridge's "Ancient Mariner," though incomplete as a sentence, well illustrates the same truth.

> "*Alone, alone, all, all alone,*
> *Alone on a wide wide sea!*
> And never a saint took pity on
> My soul in agony."

Of course the principle equally applies when the predicate is a verb or a participle. And as effect is gained by placing first all words indicating the quality, conduct, or condition of the subject, it follows that the copula also should have precedence. It is true, that the general habit of our language resists this arrangement of predicate, copula, and subject; but we may readily find instances of the additional force gained by conforming to it. Thus in the line from "Julius Cæsar"—

> "Then *burst* his mighty heart,"

priority is given to a word embodying both predicate and

copula. In a passage contained in Sir W. Scott's "Marmion," the like order is systematically employed with great effect:

"The Border slogan rent the sky!
A Home! a Gordon! *was* the cry;
Loud were the clanging blows;
Advanced,—forced back,—now low, now high,
The pennon sunk and rose;
As *bends* the bark's mast in the gale
When *rent are* rigging, shrouds, and sail,
It waver'd 'mid the foes."

Pursuing the principle further, it is obvious that for producing the greatest effect, not only should the main divisions of a sentence observe this sequence, but the subdivisions of these should have their parts similarly arranged. In nearly all cases, the predicate is accompanied by some limit or qualification called its complement. Commonly, also, the circumstances of the subject, which form its complement, have to be specified. And as these qualifications and circumstances must determine the mode in which the acts and things they belong to are conceived, precedence should be given to them. Lord Kaimes notices the fact that this order is preferable; though without giving the reason. He says:—"When a circumstance is placed at the beginning of the period, or near the beginning, the transition from it to the principal subject is agreeable: is like ascending or going upward." A sentence arranged in illustration of this will be desirable. Here is one:

—— Whatever it may be in theory, it is clear that in practice the French idea of liberty is—the right of every man to be master of the rest.

In this case, were the first two clauses, up to the word "practice" inclusive, which qualify the subject, to be placed at the end instead of the beginning, much of the force would be lost; as thus:

—— The French idea of liberty is—the right of every man to be master of the rest; in practice at least, if not in theory.

Similarly with respect to the conditions under which any

fact is predicated. Observe in the following example the effect of putting them last:

—— How immense would be the stimulus to progress, were the honour now given to wealth and title given exclusively to high achievements and intrinsic worth!

And then observe the superior effect of putting them first:

—— Were the honour now given to wealth and title given exclusively to high achievements and intrinsic worth, how immense would be the stimulus to progress!

The effect of giving priority to the complement of the predicate, as well as the predicate itself, is finely displayed in the opening of "Hyperion:"

> "*Deep in the shady sadness of a vale*
> *Far sunken from the healthy breath of morn,*
> *Far from the fiery noon, and eve's one star,*
> *Sat* grey-haired Saturn, quiet as a stone."

Here we see, not only that the predicate "sat" precedes the subject "Saturn," and that the three lines in italics, constituting the complement of the predicate, come before it; but that in the structure of this complement also, the same order is followed: each line being so composed that the qualifying words are placed before the words suggesting concrete images.

The right succession of the principal and subordinate propositions in a sentence depends on the same law. Regard for economy of the recipient's attention, which, as we find, determines the best order for the subject, copula, predicate, and their complements, dictates that the subordinate proposition shall precede the principal one, when the sentence includes two. Containing, as the subordinate proposition does, some qualifying or explanatory idea, its priority prevents misconception of the principal one; and therefore saves the mental effort needed to correct such misconception. This will be seen in the annexed example.

—— The secrecy once maintained in respect to the parliamentary debates, is still thought needful in diplomacy; and diplomacy being secret, England may any day be

unawares betrayed by its ministers into a war costing a hundred thousand lives, and hundreds of millions of treasure: yet the English pique themselves on being a self-governed people.

The two subordinate propositions, ending with the semi-colon and colon respectively, almost wholly determine the meaning of the principal proposition with which the sentence concludes; and the effect would be lost were they placed last instead of first.

From this general principle of right arrangement may also be inferred the proper order of those minor divisions into which the major divisions of sentences may be decomposed. In every sentence of any complexity the complement to the subject contains several clauses, and that to the predicate several others; and these may be arranged in greater or less conformity to the law of easy apprehension. Of course with these, as with the larger members, the succession should be from the less specific to the more specific —from the abstract to the concrete.

Now however we must notice a further condition to be fulfilled in the proper construction of a sentence; but still a condition dictated by the same general principle with the other: the condition, namely, that the words or the expressions which refer to the most nearly connected thoughts shall be brought the closest together. Evidently the single words, the minor clauses, and the leading divisions of every proposition, severally qualify each other. The longer the time that elapses between the mention of any qualifying member and the member qualified, the longer must the mind be exerted in carrying forward the qualifying member ready for use. And the more numerous the qualifications to be simultaneously remembered and rightly applied, the greater will be the mental power expended, and the smaller the effect produced. Hence, other things equal, force will be gained by so arranging the members of a sentence that these suspensions shall at any moment be the fewest in

number; and shall also be of the shortest duration. The following is an instance of defective combination.

—— A modern newspaper-statement, though probably true, would be laughed at, if quoted in a book as testimony; but the letter of a court gossip is thought good historical evidence, if written some centuries ago.

A re-arrangement of this, in accordance with the principle indicated above, will be found to increase the effect. Thus:

—— Though probably true, a modern newspaper-statement quoted in a book as testimony, would be laughed at; but the letter of a court gossip, if written some centuries ago, is thought good historical evidence.

By making this change, some of the suspensions are avoided and others shortened; while there is less liability to produce premature conceptions. The passage quoted below from "Paradise Lost" affords a fine instance of a sentence well arranged; alike in the priority of the subordinate members, in the avoidance of long and numerous suspensions, and in the correspondence between the sequence of the clauses and the sequence of the phenomena described, which, by the way, is a further prerequisite to easy apprehension, and therefore to effect.

"As when a prowling wolf,
Whom hunger drives to seek new haunt for prey,
Watching where shepherds pen their flocks at eve,
In hurdled cotes amid the field secure,
Leaps o'er the fence with ease into the fold:
Or as a thief, bent to unhoard the cash
Of some rich burgher, whose substantial doors,
Cross-barr'd and bolted fast, fear no assault,
In at the window climbs, or o'er the tiles:
So clomb the first grand Thief into God's fold;
So since into his Church lewd hirelings climb."

The habitual use of sentences in which all or most of the descriptive and limiting elements precede those described and limited, gives rise to what is called the inverted style: a title which is, however, by no means confined to this

structure, but is often used where the order of the words is simply unusual. A more appropriate title would be the *direct style*, as contrasted with the other, or *indirect style*: the peculiarity of the one being, that it conveys each thought step by step with little liability to error; and of the other, that it conveys each thought by a series of approximations, which successively correct the erroneous preconceptions that have been raised.

The superiority of the direct over the indirect form of sentence, implied by the several conclusions above drawn, must not, however, be affirmed without reservation. Though, up to a certain point, it is well for the qualifying clauses of a proposition to precede those qualified; yet, as carrying forward each qualifying clause costs some mental effort, it follows that when the number of them and the time they are carried become great, we reach a limit beyond which more is lost than is gained. Other things equal, the arrangement should be such that no concrete image shall be suggested until the materials out of which it is to be framed have been presented. And yet, as lately pointed out, other things equal, the fewer the materials to be held at once, and the shorter the distance they have to be borne, the better. Hence in some cases it becomes a question whether most mental effort will be entailed by the many and long suspensions, or by the correction of successive misconceptions.

This question may sometimes be decided by considering the capacity of the persons addressed. A greater grasp of mind is required for the ready apprehension of thoughts expressed in the direct manner, where the sentences are anywise intricate. To recollect a number of preliminaries stated in elucidation of a coming idea, and to apply them all to the formation of it when suggested, demands a good memory and considerable power of concentration. To one possessing these, the direct method will mostly seem the best; while to one deficient in them it will seem the worst

Just as it may cost a strong man less effort to carry a hundred-weight from place to place at once, than by a stone at a time; so, to an active mind it may be easier to bear along all the qualifications of an idea and at once rightly form it when named, than to first imperfectly conceive such idea, and then carry back to it, one by one, the details and limitations afterwards mentioned. While conversely, as for a boy the only possible mode of transferring a hundred-weight, is that of taking it in portions; so, for a weak mind, the only possible mode of forming a compound conception may be that of building it up by carrying separately its several parts.

That the indirect method—the method of conveying the meaning by a series of approximations—is best fitted for the uncultivated, may indeed be inferred from their habitual use of it. The form of expression adopted by the savage, as in—"Water, give me," is the simplest type of this arrangement. In pleonasms, which are comparatively prevalent among the uneducated, the same essential structure is seen; as, for instance in—"The men, they were there." Again, the old possessive case—"The king, his crown," conforms to the like order of thought. Moreover, the fact that the indirect mode is called the natural one, implies that it is the one spontaneously employed by the common people; that is —the one easiest for undisciplined minds.

There are many cases, however, in which neither the direct nor the indirect mode is the best; but in which an intermediate mode is preferable to both. When the number of circumstances and qualifications to be included in the sentence is great, the judicious course is neither to enumerate them all before introducing the idea to which they belong, nor to put this idea first and let it be remodelled to agree with the particulars afterwards mentioned; but to do a little of each. It is desirable to avoid so extremely indirect an arrangement as the following:—

—— "We came to our journey's end, at last, with no

small difficulty, after much fatigue, through deep roads, and bad weather."

Yet to transform this into an entirely direct sentence would be unadvisable; as witness:—

—— At last, with no small difficulty, after much fatigue, through deep roads, and bad weather, we came to our journey's end.

Dr. Whately, from whom we quote the first of these two arrangements, proposes this construction:—

—— "At last, after much fatigue, through deep roads and bad weather, we came, with no small difficulty, to our journey's end."

Here by introducing the words "we came" a little earlier in the sentence, the labour of carrying forward so many particulars is diminished, and the subsequent qualification "with no small difficulty" entails an addition to the thought that is easily made. But a further improvement may be effected by putting the words "we came" still earlier; especially if at the same time the qualifications be rearranged in conformity with the principle already explained, that the more abstract elements of the thought should come before the more concrete. Observe the result of making these two changes:

—— At last, with no small difficulty, and after much fatigue, we came, through deep roads and bad weather, to our journey's end.

This reads with comparative smoothness; that is—with less hindrance from suspensions and reconstructions of thought.

It should be further remarked, that even when addressing vigorous intellects, the direct mode is unfit for communicating ideas of a complex or abstract character. So long as the mind has not much to do, it may be well able to grasp all the preparatory clauses of a sentence, and to use them effectively; but if some subtlety in the argument absorb the attention it may happen that the mind, doubly

strained, will break down, and allow the elements of the thought to lapse into confusion.

Let us pass now to figures of speech. In them we may equally discern the same general law of effect. Implied in rules given for the choice and right use of them, we shall find the same fundamental requirement—economy of attention. It is indeed chiefly because they so well subserve this requirement, that figures of speech are employed.

Let us begin with the figure called Synecdoche. The advantage sometimes gained by putting a part for the whole, is due to the more convenient, or more vivid, presentation of the idea. If, instead of writing "a fleet of ten ships," we write "a fleet of ten *sail*," the picture of a group of vessels at sea is more readily suggested; and is so because the sails constitute the most conspicuous parts of vessels so circumstanced. To say, "All *hands* to the pumps," is better than to say, "All *men* to the pumps;" as it calls up a picture of the men in the special attitude intended, and so saves effort. Bringing "*grey hairs* with sorrow to the grave," is another expression, the effect of which has the same cause.

The effectiveness of Metonymy may be similarly accounted for. "The low morality of *the bar*," is a phrase both more brief and significant than the literal one it stands for. A belief in the ultimate supremacy of intelligence over brute force, is conveyed in a more concrete form, and therefore more representable form, if we substitute *the pen* and *the sword* for the two abstract terms. To say, "Beware of drinking!" is less effective than to say, "Beware of *the bottle!*" and is so, clearly because it calls up a less specific image.

The Simile is in many cases used chiefly with a view to ornament; but whenever it increases the *force* of a passage, it does so by being an economy. Here is an instance.

—— The illusion that great men and great events came

oftener in early times than they come now, is due partly to historical perspective. As in a range of equidistant columns, the furthest off seem the closest; so, the conspicuous objects of the past seem more thickly clustered the more remote they are.

To express literally the thought thus conveyed, would take many sentences; and the first elements of the picture would become faint while the imagination was busy in adding the others. But by the help of a comparison much of the effort otherwise required is saved.

Concerning the position of the Simile,* it needs only to remark, that what has been said about the order of the adjective and substantive, predicate and subject, principal and subordinate propositions, &c., is applicable here. As whatever qualifies should precede whatever is qualified, force will generally be gained by placing the simile before the object or act to which it is applied. That this arrangement is the best, may be seen in the following passage from the "Lady of the Lake:"—

> "As wreath of snow, on mountain breast,
> Slides from the rock that gave it rest,
> Poor Ellen glided from her stay,
> And at the monarch's feet she lay."

Inverting these couplets will be found to diminish the effect considerably. There are cases, however, even where the simile is a simple one, in which it may with advantage be placed last; as in these lines from Alexander Smith's "Life Drama:"—

> "I see the future stretch
> All dark and barren as a rainy sea."

The reason for this seems to be, that so abstract an idea as that attaching to the word "future," does not present

* Properly the term "simile" is applicable only to the entire figure, including the two things compared and the comparison drawn between them. But as there exists no name for the illustrative member of the figure, there seems no alternative but to employ "simile" to express this also. The context will in each case show in which sense the word is used.

itself to the mind in any definite form; and hence the subsequent arrival at the simile entails no reconstruction of the thought.

Such however are not the only cases in which this order is the more forcible. As putting the simile first is advantageous only when it is carried forward in the mind to assist in forming an image of the object or act; it must happen that if, from length or complexity, it cannot be so carried forward, the advantage is not gained. The annexed sonnet, by Coleridge, is defective from this cause.

"As when a child, on some long winter's night,
Affrighted, clinging to its grandam's knees,
With eager wond'ring and perturb'd delight
Listens strange tales of fearful dark decrees,
Mutter'd to wretch by necromantic spell;
Or of those hags who at the witching time
Of murky midnight, ride the air sublime,
And mingle foul embrace with fiends of hell;
Cold horror drinks its blood! Anon the tear
More gentle starts, to hear the beldame tell
Of pretty babes, that lov'd each other dear,
Murder'd by cruel uncle's mandate fell:
Ev'n such the shiv'ring joys thy tones impart,
Ev'n so, thou, Siddons, meltest my sad heart."

Here, from the lapse of time and accumulation of circumstances, the first member of the comparison is forgotten before the second is reached; and requires re-reading. Had the main idea been first mentioned, less effort would have been required to retain it, and to modify the conception of it into harmony with the illustrative ideas, than to remember the illustrative ideas, and refer back to them for help in forming the final image.

The superiority of the Metaphor to the Simile is ascribed by Dr. Whately to the fact that "all men are more gratified at catching the resemblance for themselves, than in having it pointed out to them." But after what has been said, the great economy it achieves will seem the more probable cause. Lear's exclamation—

"Ingratitude! thou marble-hearted fiend,"

would lose part of its effect were it changed into—

"Ingratitude! thou fiend with heart like marble;"

and the loss would result partly from the position of the simile and partly from the extra number of words required. When the comparison is an involved one, the greater force of the metaphor, due to its relative brevity, becomes much more conspicuous. If, drawing an analogy between mental and physical phenomena, we say,

—— As, in passing through a crystal, beams of white light are decomposed into the colours of the rainbow; so, in traversing the soul of the poet, the colourless rays of truth are transformed into brightly-tinted poetry;——

it is clear that in receiving the two sets of words expressing the two halves of the comparison, and in carrying the meaning of the one to help in interpreting the other, considerable attention is absorbed. Most of this is saved by putting the comparison in a metaphorical form, thus:—

—— The white light of truth, in traversing the many-sided transparent soul of the poet, is refracted into iris-hued poetry. How much is conveyed in a few words by using Metaphor, and how vivid the effect consequently produced, is everywhere shown. From "A Life Drama" may be quoted the phrase,

"I spear'd him with a jest,"

as a fine instance among the many which that poem contains. A passage in the "Prometheus Unbound," of Shelley, displays the power of the metaphor to great advantage.

"Methought among the lawns together
We wandered, underneath the young gray dawn,
And multitudes of dense white fleecy clouds
Were wandering in thick flocks along the mountains
Shepherded by the slow unwilling wind."

This last expression is remarkable for the distinctness with which it calls up the features of the scene; bringing the mind by a bound to the desired conception.

But a limit is put to the advantageous use of Metaphor,

by the condition that it must be simple enough to be understood from a hint. Evidently, if there be any obscurity in the meaning or application of it, no economy of attention will be achieved; but rather the reverse. Hence, when the comparison is complex, it is better to put it in the form of a Simile. There is, however, a species of figure, sometimes classed under Allegory, but which might well be called Compound Metaphor, that enables us to retain the brevity of the metaphorical form even where the analogy is intricate. This is done by indicating the application of the figure at the outset, and then leaving the reader or hearer to continue the parallel. Emerson has employed it with great effect in the first of his *Lectures on the Times*.

"The main interest which any aspects of the Times can have for us, is the great spirit which gases through them, the light which they can shed on the wonderful questions, What are we? and Whither do we tend? We do not wish to be deceived. Here we drift, like white sail across the wild ocean, now bright on the wave, now darkling in the trough of the sea; but from what port did we sail? Who knows? Or to what port are we bound? Who knows? There is no one to tell us but such poor weather-tossed mariners as ourselves, whom we speak as we pass, or who have hoisted some signal, or floated to us some letter in a bottle from afar. But what know they more than we? They also found themselves on this wondrous sea. No; from the older sailors nothing. Over all their speaking-trumpets the gray sea and the loud winds answer—Not in us; not in Time."

The division of Simile from Metaphor is by no means definite. Between the one extreme in which the two elements of the comparison are detailed at full length and the analogy pointed out, and the other extreme in which the comparison is implied instead of stated, come intermediate forms, in which the comparison is partly stated and partly implied. For instance:—

—— Astonished at the performances of the English plough, the Hindoos paint it, set it up, and worship it; thus turning a tool into an idol. Linguists do the same with language.—Here there is an evident advantage in leaving the reader or hearer to complete the figure. And generally these

intermediate forms are good in proportion as they do this; provided the mode of completion be obvious.

Passing over much that may be said of like purport on Hyperbole, Personification, Apostrophe, &c., let us close our remarks on construction by a typical example of effective expression. The general principle which has been enunciated is that, other things equal, the force of a verbal form or arrangement is great, in proportion as the mental effort demanded from the recipient is small. The corollaries from this general principle have been severally illustrated. But though conformity now to this and now to that requirement has been exemplified, no case of entire conformity has yet been quoted. It is indeed difficult to find one; for the English idiom does not commonly permit the order which theory dictates. A few, however, occur in Ossian. Here is one:—

"Like autumn's dark storms pouring from two echoing hills, towards each other approached the heroes. Like two deep streams from high rocks meeting, mixing, roaring on the plain: loud, rough, and dark in battle meet Lochlin and Inisfail. * * * As the noise of the troubled ocean when roll the waves on high; as the last peal of the thunder of heaven; such is the din of war."

Except in the position of the verb in the first two similes, the theoretically best arrangement is fully carried out in each of these sentences. The simile comes before the qualified image, the adjectives before the substantives, the predicate and copula before the subject, and their respective complements before them. That the passage is bombastic proves nothing; or rather, proves our case. For what is bombast but a force of expression too great for the magnitude of the ideas embodied? All that may rightly be inferred is, that only in rare cases should *all* the conditions to effective expression be fulfilled.

A more complex application of the theory may now be

made. Not only in the structures of sentences, and the uses of figures of speech, may we trace economy of the recipient's mental energy as the cause of force; but we may trace this same cause in the successful choice and arrangement of the minor images out of which some large thought is to be built. To select from a scene or event described, those elements which carry many others with them; and so, by saying a few things but suggesting many, to abridge the description; is the secret of producing a vivid impression. An extract from Tennyson's "Mariana" will well illustrate this.

> "All day within the dreamy house,
> The doors upon their hinges creaked,
> The blue fly sung in the pane; the mouse
> Behind the mouldering wainscot shriek'd,
> Or from the crevice peer'd about."

The several circumstances here specified bring with them many appropriate associations. When alone the creaking of a distant door is much more obtrusive than when talking to friends. Our attention is rarely drawn by the buzzing of a fly in the window, save when everything is still. While the inmates are moving about the house, mice usually keep silence; and it is only when extreme quietness reigns that they peep from their retreats. Hence each of the facts mentioned, presupposing various others, calls up these with more or less distinctness; and revives the feeling of dull solitude with which they are connected in our experience. Were all of them detailed instead of suggested, the mental energies would be so frittered away in attending that little impression of dreariness would be produced. Similarly in other cases. In the choice of component ideas, as in the choice of expressions, the aim must be to convey the greatest quantity of thoughts with the smallest quantity of words.

The same principle may sometimes be advantageously carried yet further, by indirectly suggesting some entirely

distinct thought in addition to the one expressed. Thus if we say,

—— The head of a good classic is as full of ancient myths, as that of a servant-girl of ghost stories;

it is manifest that besides the fact asserted, there is an implied opinion respecting the small value of much that passes as classical learning; and as this implied opinion is recognized much sooner than it can be put into words, there is gain in omitting it. In other cases, again, great effect is produced by an overt omission; provided the nature of the idea left out is obvious. A good instance occurs in *Heroes and Hero-worship*. After describing the way in which Burns was sacrificed to the idle curiosity of lion-hunters—people who sought to amuse themselves, and who got their amusement while "the Hero's life went for it!" Carlyle suggests a parallel thus:—

"Richter says, in the Island of Sumatra there is a kind of 'Light-chafers,' large Fire-flies, which people stick upon spits, and illuminate the ways with at night. Persons of condition can thus travel with a pleasant radiance, which they much admire. Great honour to the Fire-flies! But—!—"

Before inquiring whether the law of effect thus far traced, explains the impressiveness of poetry as compared with prose, it will be needful to notice some causes of force in expression which had not yet been mentioned. These are not, properly speaking, additional causes; but rather secondary ones, originating from those already specified. One is that mental excitement spontaneously prompts those forms of speech which have been pointed out as the most effective. "Out with him!" "Away with him!" are the cries of angry citizens at a disturbed meeting. A voyager, describing a terrible storm he had witnessed, would rise to some such climax as—"Crack went the ropes, and down came the mast." Astonishment

may be heard expressed in the phrase—"Never was there such a sight!" All of which sentences are constructed after the direct type. Again, there is the fact that excited persons are given to figures of speech. The vituperation of the vulgar abounds with them. "Beast," "brute," "gallows rogue," "cut-throat villain," these, and like metaphors or metaphorical epithets, call to mind a street quarrel. Further, it may be noticed that extreme brevity is a trait of passionate language. The sentences are generally incomplete; and frequently important words are left to be gathered from the context. Great admiration does not vent itself in a precise proposition, as—"It is beautiful;" but in the simple exclamation,—"Beautiful!" He who, when reading a lawyer's letter, should say, "Vile rascal!" would be thought angry; while, "He is a vile rascal," would imply comparative coolness. Thus alike in the order of the words, in the frequent use of figures, and in extreme conciseness, the natural utterances of excitement conform to the theoretical conditions to forcible expression.

Hence such forms of speech acquire a secondary strength from association. Having, in daily intercourse, heard them in connection with vivid mental impressions; and having been accustomed to meet with them in writing of unusual power; they come to have in themselves a species of force. The emotions that have from time to time been produced by the strong thoughts wrapped up in these forms, are partially aroused by the forms themselves. These create a preparatory sympathy; and when the striking ideas looked for are reached, they are the more vividly pictured.

The continuous use of words and forms that are alike forcible in themselves and forcible from their associations, produces the impressive species of composition which we call poetry. The poet habitually adopts those symbols of thought, and those methods of using them, which instinct

and analysis agree in choosing as most effective. On turning back to the various specimens which have been quoted, it will be seen that the direct or inverted form of sentence predominates in them; and that to a degree inadmissible in prose. Not only in the frequency, but in what is termed the violence of the inversions, may this distinction be remarked. The abundant use of figures, again, exhibits the same truth. Metaphors, similes, hyperboles, and personifications, are the poet's colours, which he has liberty to employ almost without limit. We characterize as "poetical" the prose which uses these appliances of language with frequency; and condemn it as "over florid" or "affected" long before they occur with the profusion allowed in verse. Once more, in brevity —the other requisite of forcible expression which theory points out and emotion spontaneously fulfils—poetical phraseology differs from ordinary phraseology. Imperfect periods are frequent; elisions are perpetual; and many minor words which would be deemed essential in prose, are dispensed with.

Thus poetry is especially impressive partly because it conforms to all the laws of effective speech, and partly because in so doing it imitates the natural utterances of excitement. While the matter embodied is idealized emotion, the vehicle is the idealized language of emotion. As the musical composer catches the cadences in which our feelings of joy and sympathy, grief and despair, vent themselves, and out of these germs evolves melodies suggesting higher phases of these feelings; so, the poet develops from the typical expressions in which men utter passion and sentiment, those choice forms of verbal combination in which concentrated passion and sentiment may be fitly presented.

There is one peculiarity of poetry conducing much to its effect—the peculiarity which is indeed usually thought its characteristic one—still remaining to be considered: we

mean its rhythmical structure. This, improbable though it seems, will be found to come under the same generalization with the others. Like each of them, it is an idealization of the natural language of emotion, which is not uncommonly more or less metrical if the emotion be not too violent; and like each of them it economizes the reader's or hearer's attention. In the peculiar tone and manner we adopt in uttering versified language, may be discerned its relationship to the feelings; and the pleasure which its measured movement gives, is ascribable to the comparative ease with which words metrically arranged can be recognized. This last position will not be at once admitted; but explanation will justify it. If, as we have seen, there is an expenditure of mental energy in so listening to verbal articulations as to identify the words, or in that silent repetition of them which goes on in reading, then, any mode of so combining words as to present a regular recurrence of certain traits which can be anticipated, will diminish that strain on the attention entailed by the total irregularity of prose. Just as the body, when receiving a series of varying concussions, must keep its muscles ready to meet the most violent of them, as not knowing when such may come; so, the mind when receiving unarranged articulations, must keep its perceptive faculties active enough to recognize the least easily caught sounds. And as, if the concussions recur in a definite order, the body may husband its forces by adjusting the resistance needful for each concussion; so, if the syllables be rhythmically arranged, the mind may economize its energies by anticipating the attention required for each syllable. Farfetched though this idea will be thought, introspection countenances it. That we *do* take advantage of metrical language to adjust our perceptive faculties to the expected articulations, is clear from the fact that we are balked by halting versification. Much as at the bottom of a flight of stairs, a step more or less than we counted upon gives us a

shock; so, too, does a misplaced accent or a supernumerary syllable. In the one case, we *know* that there is an erroneous pre-adjustment; and we can scarcely doubt that there is one in the other. But if we habitually pre-adjust our perceptions to the measured movement of verse, the physical analogy above given renders it probable that by so doing we economize attention; and hence that metrical language is more effective than prose, because it enables us to do this.

Were there space, it might be worth while to inquire whether the pleasure we take in rhyme, and also that which we take in euphony, are not partly ascribable to the same general cause.

A few paragraphs only, can be devoted to a second division of our subject. To pursue in detail the laws of effect, as applying to the larger features of composition, would carry us beyond our limits. But we may briefly indicate a further aspect of the general principle hitherto traced, and hint a few of its wider applications.

Thus far, we have considered only those causes of force in language which depend on economy of the mental *energies*. We have now to glance at those which depend on economy of the mental *sensibilities*. Questionable though this division may be as a psychological one, it will serve roughly to indicate the remaining field of investigation. It will suggest that besides considering the extent to which any faculty or group of faculties is tasked in receiving a form of words and constructing its contained idea, we have to consider the state in which this faculty or group of faculties is left; and how the reception of subsequent sentences and images will be influenced by that state. Without going fully into so wide a topic as the action of faculties and its reactive effects, it will suffice to recall the fact that every faculty is exhausted by exercise.

This generalization, which our bodily experiences force upon us, and which in daily speech is recognized as true of the mind as a whole, is true of each mental power, from the simplest of the senses to the most complex of the sentiments. If we hold a flower to the nose for long, we become insensible to its scent. We say of a brilliant flash of lightning that it blinds us; which means that our eyes have for a time lost their ability to appreciate light. After eating honey, we are apt to think our tea is without sugar. The phrase "a deafening roar," implies that men find a very loud sound temporarily incapacitates them for hearing faint sounds. To a hand which has for some time carried a heavy body, small bodies afterwards lifted seem to have lost their weight. Now, the truth thus exemplified, may be traced throughout. Alike of the reflective faculties, the imagination, the perceptions of the beautiful, the ludicrous, the sublime, it may be shown that action exhausts; and that in proportion as the action is violent the subsequent prostration is great.

Equally throughout the whole nature, may be traced the law that exercised faculties are ever tending to resume their original states. Not only after continued rest, do they regain their full powers—not only are brief cessations in the demands on them followed by partial re-invigoration; but even while they are in action, the resulting exhaustion is ever being neutralized. The processes of waste and repair go on together. Hence with faculties habitually exercised—as the senses of all persons, or the muscles of any one who is strong—it happens that, during moderate activity, the repair is so nearly equal to the waste, that the diminution of power is scarcely appreciable. It is only when effort has been long continued, or has been violent, that repair becomes so far in arrear of waste as to cause a perceptible enfeeblement. In all cases, however, when, by the action of a faculty, waste has been incurred, *some* lapse

of time must take place before full efficiency can be re-acquired; and this time must be long in proportion as the waste has been great.

Keeping in mind these general truths, we shall be in a condition to understand certain causes of effect in composition now to be considered. Every perception received, and every conception framed, entailing some amount of waste in the nervous system, and the efficiency of the faculties employed being for a time, though often but momentarily, diminished; the resulting partial inability affects the acts of perception and conception that immediately succeed. Hence the vividness with which images are pictured must, in many cases, depend on the order of their presentation; even when one order is as convenient to the understanding as the other. Sundry facts illustrate this truth, and are explained by it: instance climax and anti-climax. The marked effect obtained by placing last the most striking of any series of ideas, and the weakness —often the ludicrous weakness—produced by reversing this arrangement, depends on the general law indicated. As immediately after looking at the sun we cannot perceive the light of a fire, while by looking at the fire first and the sun afterwards we can perceive both; so, after receiving a brilliant, or weighty, or terrible thought, we cannot properly appreciate a less brilliant, less weighty, or less terrible one, though by reversing the order, we can appreciate each. In Antithesis, again, the like truth is exemplified. The opposition of two thoughts which are the reverse of each other in some prominent trait, insures an impressive effect; and does this by giving a momentary relaxation to the faculties addressed. If, after a series of ordinary images exciting in a moderate degree to the emotion of reverence, or approbation, or beauty, the mind has presented to it an insignificant, or unworthy, or ugly image: the structure which yields the emotion of reverence, or approbation, or beauty, having for the time nothing to do, tends to resume

its full power; and will immediately afterwards appreciate anything vast, admirable, or beautiful better than it would otherwise do. Conversely, where the idea of absurdity due to extreme insignificance is to be produced, it may be intensified by placing it after something impressive; especially if the form of phrase implies that something still more impressive is coming. A good illustration of the effect gained by thus presenting a petty idea to a consciousness which has not yet recovered from the shock of an exciting one, occurs in a sketch by Balzac. His hero writes to a mistress who has cooled towards him, the following letter:—

"Madame,—Votre conduite m'étonne autant qu'elle m'afflige. Non contente de me déchirer le cœur par vos dédains, vous avez l'indélicatesse de me retenir une brosse à dents, que mes moyens ne me permettent pas de remplacer, mes propriétés étant grevées d'hypothèques au delà de leur valeur.

"Adieu, trop belle et trop ingrate amie! Puissions-nous nous revoir dans un monde meilleur!

"CHARLES-EDOUARD."

Thus the phenomena of Climax, Antithesis, and Anti-climax, alike result from this general principle. Improbable as these momentary variations in susceptibility may seem, we cannot doubt their occurrence when we contemplate the analogous variations in the susceptibility of the senses. Every one knows that a patch of black on a white ground looks blacker, and a patch of white on a black ground looks whiter, than elsewhere. As the blackness and the whiteness are really the same, the only assignable cause, is a difference in their actions upon us, dependent on the different states of our faculties. The effect is due to a visual antithesis.

But this extension of the general principle of economy—this further condition to effective composition, that the sensitiveness of the faculties must be husbanded—includes much more than has been yet hinted. Not only does it follow that certain arrangements and certain juxtapositions of connected ideas are best; but also that some modes of dividing and presenting a subject will be more striking

than others, irrespective of logical cohesion. We are shown why we must progress from the less interesting to the more interesting; alike in the composition as a whole, and in each successive portion. At the same time, the indicated requirement negatives long continuity of the same kind of thought, or repeated production of like effects. It warns us against the error committed by Pope in his poems and by Bacon in his essays—the error of constantly employing forcible forms of expression. As the easiest posture by and by becomes fatiguing, and is with pleasure exchanged for one less easy; so, the most perfectly-constructed sentences unceasingly used must cause weariness, and relief will be given by using those of inferior kinds. Further, we may infer not only that we ought to avoid generally combining our words in one manner, however good, or working out our figures and illustrations in one way, however telling; but that we ought to avoid anything like uniform adherence to the wider conditions of effect. We should not make every division of our subject progress in interest; we should not always rise to a climax. As we saw that in single sentences it is but rarely allowable to fulfil all the conditions to strength; so, in the larger sections of a composition we must not often conform entirely to the principles indicated. We must subordinate the component effects to the total effect.

The species of composition which the law we have traced out indicates as the perfect one, is the one which genius tends naturally to produce. As we found that the kinds of sentence which are theoretically best, are those commonly employed by superior minds, and by inferior minds when temporarily exalted; so, we shall find that the ideal form for a poem, essay, or fiction, is that which the ideal writer would evolve spontaneously. One in whom the powers of expression fully responded to the state of feeling, would unconsciously use that variety in the mode

of presenting his thoughts, which Art demands. Constant employment of one species of phraseology implies an undeveloped linguistic faculty. To have a specific style is to be poor in speech. If we remember that in the far past, men had only nouns and verbs to convey their ideas with, and that from then to now the progress has been towards more numerous implements of thought, and towards greater complexity and variety in their combinations; we may infer that, in the use of sentences, we are at present much what the primitive man was in the use of words; and that a continuance of the process which has hitherto gone on, must produce increasing heterogeneity in our modes of expression. As now, in a fine nature, the play of the features, the tones of the voice and its cadences, vary in harmony with every thought uttered; so, in one possessed of fully-developed powers of language, the mould in which each combination of words is cast will vary with, and be appropriate to, the mental state. That a perfectly-endowed man must unconsciously write in all styles, we may infer from considering how styles originate. Why is Johnson pompous, Goldsmith simple? Why is one author abrupt, another involved, another concise? Evidently in each case the habitual mode of utterance depends on the habitual balance of the nature. The dominant feelings have by use trained the intellect to represent them. But while long habit has made it do this efficiently, it remains, from lack of practice, unable to do the like for the less active feelings; and when these are excited, the usual verbal forms undergo but slight modifications. But let the ability of the intellect to represent the mental state be complete, and this fixity of style will disappear. The perfect writer will be now rhythmical and now irregular; here his language will be plain and there ornate; sometimes his sentences will be balanced and at other times unsymmetrical; for a while there will be considerable sameness, and then again great variety. His mode of

expression naturally responding to his thought and emotion, there will flow from his pen a composition changing as the aspects of his subject change. He will thus without effort conform to what we have seen to be the laws of effect. And while his work presents to the reader that variety needful to prevent continuous exertion of the same faculties, it will also answer to the description of all highly-organized products both of man and nature. It will be, not a series of like parts simply placed in juxtaposition, but one whole made up of unlike parts that are mutually dependent.

POSTSCRIPT.—The conclusion that because of their comparative brevity and because of those stronger associations formed by more frequent use, words of Old-English origin are preferable to words derived from Latin or Greek, should be taken with two qualifications, which it seems needful to add here.

In some cases the word furnished by our original tongue, and the corresponding word directly or indirectly derived from Latin, though nominally equivalents, are not actually such; and the word of Latin origin, by certain extra connotations it has acquired, may be the more expressive. For instance, we have no word of native origin which can be advantageously substituted for the word "grand." No such words as "big" or "great," which connote little more than superiority in size or quantity, can be used instead: they do not imply that qualitative superiority which is associated with the idea of grandeur. As adopted into our own language, the word "grand" has been differentiated from "great" by habitual use in those cases where the greatness has an æsthetic superiority. In this case, then, a word of Latin origin is better than its nearest equivalent of native origin, because by use it has acquired an additional meaning. And here, too, we may conveniently

note the fact that the greater brevity of a word does not invariably conduce to greater force. Where the word, instead of being one conveying a subordinate component of the idea the sentence expresses, is one conveying the central element of the idea, on which the attention may with advantage rest a moment, a longer word is sometimes better than a shorter word. Thus it may be held that the sentence—"It is grand" is not so effective as the sentence —"It is magnificent." Besides the fact that here greater length of the word favours a longer dwelling on the essential part of the thought, there is the fact that its greater length, aided by its division into syllables, gives opportunity for a cadence appropriate to the feeling produced by the thing characterized. By an ascent of the voice on the syllable "nif," and an utterance of this syllable, not only in a higher note, but with greater emphasis than the preceding or succeeding syllables, there is implied that emotion which contemplation of the object produces; and the emotion thus implied is, by sympathy, communicated. One may say that in the case of these two words, if the imposingness is alone to be considered, the word "magnificent" may with advantage be employed; but if the sentence expresses a proposition in which, not the imposingness itself, but something *about* the imposingness, is to be expressed, then the word "grand" is preferable.

The second qualification above referred to, concerns the superiority of words derived from Latin or Greek, in cases where more or less abstract ideas have to be expressed. In such cases it is undesirable to use words having concrete associations; for such words, by the very vividness with which they call up thoughts of particular objects or particular actions, impede the formation of conceptions which refer, not to particular objects and actions, but to general truths concerning objects or actions of kinds that are more or less various. Thus, such an expression as "the colligation of facts" is better for philosophical purposes than such

an expression as "the tying together of facts." This last expression cannot be used without suggesting the thought of a bundle of material things bound up by a string or cord —a thought which, in so far as the materiality of its components is concerned, conflicts with the conception to be suggested. Though it is true that when its derivation is remembered, "colligation" raises the same thought, yet, as the thought is not so promptly or irresistibly raised, it stands less in the way of the abstract conception with which attention should be exclusively occupied.

USE AND BEAUTY.

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In one of his essays, Emerson remarks, that what Nature at one time provides for use, she afterwards turns to ornament; and he cites in illustration the structure of a sea-shell, in which the parts that have for a while formed the mouth are at the next season of growth left behind, and become decorative nodes and spines.

Ignoring the implied teleology, which does not here concern us, it has often occurred to me that this same remark might be extended to the progress of Humanity. Here, too, the appliances of one era serve as embellishments to the next. Equally in institutions, creeds, customs, and superstitions, we may trace this evolution of beauty out of what was once purely utilitarian.

The contrast between the feeling with which we regard portions of the Earth's surface still left in their original state, and the feeling with which the savage regarded them, is an instance that comes first in order of time. If any one walking over Hampstead Heath, will note how strongly its picturesqueness is brought out by contrast with the surrounding cultivated fields and the masses of houses lying in the distance; and will further reflect that, had this irregular gorse-covered surface extended on all sides to the horizon, it

would have looked dreary and prosaic rather than pleasing; he will see that to the primitive man a country so clothed presented no beauty at all. To him it was merely a haunt of wild animals, and a ground out of which roots might be dug. What have become for us places of relaxation and enjoyment—places for afternoon strolls and for gathering flowers—were his places for labour and food, probably arousing in his mind none but utilitarian associations.

Ruined castles afford obvious instances of this metamorphosis of the useful into the beautiful. To feudal barons and their retainers, security was the chief, if not the only end, sought in choosing the sites and styles of their strongholds. Probably they aimed as little at the picturesque as do the builders of cheap brick houses in our modern towns. Yet what were erected for shelter and safety, and what in those early days fulfilled an important function in the social economy, have now assumed a purely ornamental character. They serve as scenes for picnics; pictures of them decorate our drawing-rooms; and each supplies its surrounding districts with legends for Christmas Eve.

On following out the train of thought suggested by this last illustration, we may see that not only do the material exuviæ of past social states become the ornaments of our landscapes; but that past habits, manners, and arrangements, serve as ornamental elements in our literature. The tyrannies which, to the serfs who bore them, were harsh and dreary facts; the feuds which, to those who took part in them, were very practical life-and-death affairs; the mailed, moated, sentinelled security which was irksome to the nobles who needed it; the imprisonments, and tortures, and escapes, which were stern and quite prosaic realities to all concerned in them; have become to us material for romantic tales—material which, when woven into Ivanhoes and Marmions, serves for amusement in leisure hours, and becomes poetical by contrast with our daily lives.

Thus, also, is it with extinct creeds. Stonehenge, which

in the hands of the Druids had a governmental influence over men, is in our day a place for antiquarian excursions; and its attendant priests are worked up into an opera. Greek sculptures, preserved for their beauty in our galleries of art, and copied for the decoration of pleasure grounds and entrance halls, once lived in men's minds as gods demanding obedience; as did also the grotesque idols that now amuse the visitors to our museums.

Equally marked is this change of function in the case of minor superstitions. The fairy lore, which in past times was matter of grave belief, and held sway over people's conduct, have since been transformed into ornament for *A Midsummer Night's Dream*, *The Tempest*, *The Fairy Queen*, and endless small tales and poems; and still affords subjects for children's story-books, themes for ballets, and plots for Planché's burlesques. Gnomes, and genii, and afrits, losing their terrors, give piquancy to the woodcuts in our illustrated edition of the *Arabian Nights*. While ghost-stories, and tales of magic and witchcraft, after serving to amuse boys and girls in their leisure hours, become matter for jocose allusions that enliven tea-table conversation.

Even our serious literature and our speeches are relieved by ornaments drawn from such sources. A Greek myth is often used as a parallel by which to vary the monotony of some grave argument. The lecturer breaks the dead level of his practical discourse by illustrations drawn from bygone customs, events, or beliefs. And metaphors, similarly derived, give brilliancy to political orations, and to *Times* leading articles.

Indeed, on careful inquiry, I think it will be found that we turn to purposes of beauty most byegone phenomena which are at all conspicuous. The busts of great men in our libraries, and their tombs in our churches; the once useful but now purely ornamental heraldic symbols; the monks, nuns, and convents, which give interest to a certain class of novels; the bronze mediæval soldiers used for

embellishing drawing-rooms; the gilt Apollos which recline on time-pieces; the narratives that serve as plots for our great dramas; and the events that afford subjects for historical pictures;—these and such like illustrations of the metamorphosis of the useful into the beautiful, are so numerous as to suggest that, did we search diligently enough, we should find that in some place, or under some circumstance, nearly every notable product of the past has assumed a decorative character.

And here the mention of historical pictures reminds me that an inference may be drawn from all this, bearing directly on the practice of art. It has of late years been a frequent criticism upon our historical painters, that they err in choosing their subjects from the past; and that, would they found a genuine and vital school, they must render on canvas the life and deeds and aims of our own time. If, however, there be any significance in the foregoing facts, it seems doubtful whether this criticism is a just one. For if it be the course of things that what has performed some active function in society during one era, becomes available for ornament in a subsequent one; it almost follows that, conversely, whatever is performing some active function now, or has very recently performed one, does not possess the ornamental character; and is, consequently, inapplicable to any purpose of which beauty is the aim, or of which it is a needful ingredient.

Still more reasonable will this conclusion appear, when we consider the nature of this process by which the useful is changed into the ornamental. An essential pre-requisite to all beauty is *contrast*. To obtain artistic effect, light must be put in juxtaposition with shade, bright colours with dull colours, a fretted surface with a plain one. *Forte* passages in music must have *piano* passages to relieve them; concerted pieces need interspersing with solos; and rich chords must not be continuously repeated. In the drama we demand contrast of characters, of scenes, of sentiment, of

style. In prose composition an eloquent passage should have a comparatively plain setting; and in poems great effect is obtained by occasional change of versification. This general principle will, I think, explain the transformation of the bygone useful into the present beautiful. It is by virtue of their contrast with our present modes of life, that past modes of life look interesting and romantic. Just as a picnic, which is a temporary return to an aboriginal condition, derives, from its unfamiliarity, a certain poetry which it would not have were it habitual; so, everything ancient gains, from its relative novelty to us, an element of interest. Gradually as, by the growth of society, we leave behind the customs, manners, arrangements, and all the products, material and mental, of a bygone age—gradually as we recede from these so far that there arises a conspicuous difference between them and those we are familiar with; so gradually do they begin to assume to us a poetical aspect, and become applicable for ornament. And hence it follows that things and events which are close to us, and which are accompanied by associations of ideas not markedly contrasted with our ordinary associations, are *relatively* inappropriate for purposes of art. I say relatively because an incident of modern life or even of daily life may acquire adequate fitness for art purposes by an unusualness of some other kind than that due to unlikeness between past and present.

THE SOURCES OF ARCHITECTURAL TYPES.

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WHEN lately looking through the gallery of the Old Water-Colour Society, I was struck with the incongruity produced by putting regular architecture into irregular scenery. In one case, where the artist had introduced a symmetrical Grecian edifice into a mountainous and wild landscape, the discordant effect was particularly marked. "How very unpicturesque," said a lady to her friend, as they passed; showing that I was not alone in my opinion. Her phrase, however, set me speculating. Why unpicturesque? Picturesque means, like a picture—like what men choose for pictures. Why then should this be not fit for a picture?

Thinking the matter over, it seemed to me that the artist had sinned against that harmony of sentiment which is essential to a good picture. When the other constituents of a landscape have irregular forms, any artificial structure introduced should have an irregular form, that it may seem *part* of the landscape. The same general character must pervade it and the surrounding objects; otherwise it, and the scene amid which it stands, become not *one* thing but *two* things; and we say that it looks out of place. Or, speaking psychologically, the associated ideas called

up by a building with its wings, windows, columns, and all its parts symmetrically disposed, differ widely from the ideas associated with an unsymmetrical landscape; and the one set of ideas tends to banish the other.

Pursuing the train of thought, sundry illustrative facts came to mind. I remembered that a castle, which is usually more irregular in outline than any other kind of building, pleases us most when seated amid crags and precipices; while a castle on a plain seems incongruous. The partly-regular and partly-irregular forms of our old farm-houses, and our gabled gothic manors and abbeys, appear quite in harmony with an undulating, wooded country. In towns we prefer symmetrical architecture; and in towns it produces in us no feeling of incongruity, because all surrounding things—men, horses, vehicles—are symmetrical also.

And here I was reminded of a notion that has frequently recurred to me; namely, that there is some relationship between the several kinds of architecture and the several classes of natural objects. Buildings in the Greek and Roman styles seem, in virtue of their symmetry, to take their type from animal life. In the partially-irregular Gothic, ideas derived from the vegetable world appear to predominate. And wholly irregular buildings, such as castles, may be considered as having inorganic forms for their basis.

Whimsical as this speculation looks at first sight, it is countenanced by numerous facts. The connexion between symmetrical architecture and animal forms, may be inferred from the *kind* of symmetry we expect, and are satisfied with, in regular buildings. In a Greek temple we require that the front shall be symmetrical in itself, and that the two flanks shall be alike; but we do not look for uniformity between the flanks and the front, nor between the front and the back. The identity of this symmetry with that found in animals is obvious. Again, why is it that a

building making any pretensions to symmetry displeases us if not quite symmetrical? Probably the reply will be—Because we see that the designer's idea is not fully carried out; and that hence our love of completeness is offended. But then there come the further questions—How do we know that the architect's conception was symmetrical? Whence comes this notion of symmetry which we have, and which we attribute to him? Unless we fall back upon the old doctrine of innate ideas, we must admit that the idea of bi-lateral symmetry is derived from without; and to admit this is to admit that it is derived from the higher animals.

That there is some relationship between Gothic architecture and vegetal forms is generally admitted. The often-remarked similarity between a groined nave and an avenue of trees with interlacing branches, shows that the fact has forced itself on observation. It is not only in this, however, that the kinship is seen. It is seen still better in the essential characteristic of Gothic; namely, what is termed its *aspiring* tendency. That predominance of vertical lines which so strongly distinguishes Gothic from other styles, is the most marked peculiarity of trees, when compared with animals or rocks. A tall Gothic tower, with its elongated apertures and clusters of thin projections running from bottom to top, suggests a vague idea of growth.

Of the alleged connexion between inorganic forms and the wholly irregular and the castellated styles of building, we have, I think, some proof in the fact that when an edifice is irregular, the *more* irregular it is the more it pleases us. I see no way of accounting for this fact, save by supposing that the greater the irregularity the more strongly are we reminded of the inorganic forms typified, and the more vividly are aroused the agreeable ideas of rugged and romantic scenery associated with those forms.

Further evidence of these relationships of styles of

architecture to classes of natural objects, is supplied by the kinds of decoration they respectively present. The public buildings of Greece, while characterized in their outlines by the bi-lateral symmetry seen in the higher animals, have their pediments and entablatures covered with sculptured men and beasts. Egyptian temples and Assyrian palaces, similarly symmetrical in their general plan, are similarly ornamented on their walls and at their doors. In Gothic, again, with its grove-like ranges of clustered columns, we find rich foliated ornaments abundantly employed. And accompanying the totally irregular, inorganic outlines of old castles, we see neither vegetal nor animal decorations. The bare, rock-like walls are surmounted by battlements, consisting of almost plain blocks, which remind us of the projections on the edge of a rugged cliff.

But perhaps the most significant fact is the harmony observable between each type of architecture and the scenes in which it is indigenous. For what is the explanation of this harmony, unless it be that the predominant character of surrounding things has, in some way, determined the mode of building adopted?

That the harmony exists is clear. Equally in the cases of Egypt, Assyria, Greece, and Rome, town life preceded the construction of the symmetrical buildings that have come down to us. And town life is one in which, as already observed, the majority of familiar objects are symmetrical. We habitually feel the naturalness of this association. Amid the fields, a formal house, with a central door flanked by equal numbers of windows to right and left, strikes us as unrural—looks as though transplanted from a street; and we cannot look at one of those stuccoed villas, with mock-windows arranged to balance the real ones, without being reminded of the suburban residence of a retired tradesman.

In styles indigenous in the country, we not only find

the general irregularity characteristic of surrounding things, but we may trace some kinship between each kind of irregularity and the local circumstances. We see the broken rocky masses amid which castles are often placed, mirrored in their stern, inorganic forms. In abbeys, and such-like buildings, which are commonly found in sheltered districts, we find no such violent dislocations of masses and outlines; and the nakedness appropriate to the fortress is replaced by decorations reflecting the neighbouring woods. Between a Swiss cottage and a Swiss view there is an evident relationship. The angular roof, so bold and so disproportionately large when compared to other roofs, reminds one of the adjacent mountain peaks; and the broad overhanging eaves have a sweep and inclination like those of the lower branches of a pine tree. Consider, too, the apparent kinship between the flat roofs that prevail in Eastern cities, interspersed with occasional minarets, and the plains that commonly surround them, dotted here and there by palm trees. Contemplate a picture of one of these places, and you are struck by the predominance of horizontal lines, and their harmony with the wide stretch of the landscape.

That the congruity here pointed out should hold in every case must not be expected. The Pyramids, for example, do not seem to come under this generalization. Their repeated horizontal lines do indeed conform to the flatness of the neighbouring desert; but their general contour seems to have no adjacent analogue. Considering, however, that migrating races, carrying their architectural systems with them, would naturally produce buildings having no relationship to their new localities; and that it is not always possible to distinguish styles which are indigenous, from those which are naturalized; numerous anomalies must be looked for.

The general idea above illustrated will perhaps be somewhat misinterpreted. Possibly some will take the pro-

position to be that men *intentionally* gave to their buildings the leading characteristics of neighbouring objects. But this is not what is meant. I do not suppose that they did so in times past, any more than they do so now. The hypothesis is, that in their choice of forms men are unconsciously influenced by the forms encircling them. That flat-roofed, symmetrical architecture should have originated in the East, among pastoral tribes surrounded by their herds and by wide plains, seems to imply that the builders were swayed by the horizontality and symmetry to which they were habituated. And the harmony which we have found to exist in other cases between indigenous styles and their localities, implies the general action of like influences. Indeed, on considering the matter psychologically, I do not see how it could well be otherwise. For as all conceptions must be made up of images, and parts of images, received through the senses; and as imagination will most readily run in the direction of habitual perceptions; it follows that the characteristic which predominates in habitual perceptions must impress itself on designs.

GRACEFULNESS.

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We do not ascribe gracefulness to cart-horses, tortoises, and hippopotami, in all of which the powers of movement are relatively inferior; but we ascribe it to greyhounds, antelopes, race-horses, all of which have highly efficient locomotive organs. What, then, is this distinctive peculiarity of structure and action which we call Grace?

One night while watching a dancer, and inwardly condemning her *tours de force* as barbarisms which would be hissed, were not people such cowards as always to applaud what they think it the fashion to applaud, I remarked that the truly graceful motions occasionally introduced, were those performed with comparatively little effort. After calling to mind sundry confirmatory facts, I presently concluded that grace, as applied to motion, describes motion that is effected with economy of force; grace, as applied to animal forms, describes forms capable of this economy; grace, as applied to postures, describes postures which may be maintained with this economy; and grace, as applied to inanimate objects, describes such as exhibit certain analogies to these attitudes and forms.

That this generalization, if not the whole truth, contains at least a large part of it, will, I think, become obvious, on

considering how habitually we couple the words *easy* and *graceful;* and still more, on calling to mind some of the facts on which this association is based. The attitude of a soldier, drawing himself bolt upright when his serjeant shouts "attention," is more remote from gracefulness than when he relaxes at the words "stand at ease." The *gauche* visitor sitting stiffly on the edge of his chair, and his self-possessed host, whose limbs and body dispose themselves as convenience dictates, are contrasts as much in effort as in elegance. When standing, we commonly economise power by throwing the weight chiefly on one leg, which we straighten to make it serve as a column, while we relax the other; and to the same end, we allow the head to lean somewhat on one side. Both these attitudes are imitated in sculpture as elements of grace.

Turning from attitudes to movements, current remarks will be found to imply the same relationship. No one praises as graceful, a walk that is irregular or jerking, and so displays waste of power; no one sees any beauty in the waddle of a fat man, or the trembling steps of an invalid, in both of which effort is visible. But the style of walking we admire is moderate in velocity, perfectly rhythmical, unaccompanied by violent swinging of the arms, and giving us the impression that there is no conscious exertion, while there is no force thrown away. In dancing, again, the prevailing difficulty—the proper disposal of the arms—well illustrates the same truth. Those who fail in overcoming this difficulty give the spectator the impression that their arms are a trouble to them; they are held stiffly in some meaningless attitude, at an obvious expense of power; they are checked from swinging in the directions in which they would naturally swing; or they are so moved that, instead of helping to maintain the equilibrium, they endanger it. A good dancer, on the contrary, makes us feel that, so far from the arms being in the way, they are of great use. Each

motion of them, while it seems naturally to result from a previous motion of the body, is turned to some advantage. We perceive that it has facilitated instead of hindered the general action; or, in other words—that an economy of effort has been achieved. Any one wishing to distinctly realize this fact, may readily do so by studying the action of the arms in walking. Let him place his arms close to his sides, and there keep them, while walking with some rapidity. He will unavoidably fall into a backward and forward motion of the shoulders, of a wriggling, ungraceful character. After persevering in this for a space, until he finds that the action is not only ungraceful but fatiguing, let him allow his arms to swing as usual. The wriggling of the shoulders will cease; the body will move equably forward; and comparative ease will be felt. On analyzing this fact, he may perceive that the backward motion of each arm is simultaneous with the forward motion of the corresponding leg. If he will attend to his muscular sensations, he will find that this backward swing of the arm is a counterbalance to the forward swing of the leg; and that it is easier to produce this counterbalance by moving the arm than by contorting the body, as he otherwise must do.*

The action of the arms in walking being thus understood, it will be manifest that the graceful employment of them in dancing is simply a complication of the same thing; and that a good dancer is one having so acute a muscular perception as at once to feel in what direction the arms

* A parallel fact, further elucidating this, is supplied by a locomotive engine. On looking at the driving wheel, there will be found, besides the boss to which the connecting rod is attached, a corresponding mass of metal on the opposite side of the wheel, and equidistant from the centre; or, if the engine be one having inside cylinders, then, on looking between the spokes of the driving-wheel, it will be seen that against each crank is a block of iron, similar to it in size, but projecting from the axle in the reverse direction. Evidently, being placed on opposite sides of the centre of motion, each crank and its counterbalance move in opposite directions relatively to the axle; and by so doing, neutralise each other's perturbing effects, and permit a

should be moved to counterbalance any motion of the body or legs.

This connexion between gracefulness and economy of force, will be most clearly recognized by those who skate. They will remember that all early attempts, and especially the first timid experiments in figure-skating, are alike awkward and fatiguing; and that the acquirement of skill is also the acquirement of ease. The requisite confidence, and a due command of the feet having been obtained, those twistings of the trunk and gyrations of the arms, previously used to maintain the balance, are found needless. The body is allowed to follow without control the impulse given to it; the arms to swing where they will; and it is clearly felt that the graceful way of performing any evolution is the way that costs least effort. Spectators can scarcely fail to see the same fact, if they look for it.

The reference to skating suggests that graceful motion might be defined as motion in curved lines. Certainly, straight and zig-zag movements are excluded from the conception. The sudden stoppages which angular movements imply, are its antithesis; for a leading trait of grace is continuity, flowingness. It will be found, however, that this is merely another aspect of the same truth; and that motion in curved lines is economical motion. Given certain successive positions to be assumed by a limb, then if it be moved in a straight line to the first of these positions, suddenly arrested, and then moved in another direction straight to the second position, and so on, it is clear that at each arrest, the momentum previously given to the limb must be destroyed at a certain cost of force,

smooth rotation. This relationship which exists between the motions of the counterbalance and the crank, is analogous to that which exists between the motions of the arms and legs in walking; and in the early days of railway-locomotion, before these counterbalance weights were used, locomotive driving-wheels were subject to violent oscillations, analogous to those jerkings of the shoulders which arise when we walk fast without moving our arms.

and a new momentum given to it at a further cost of force; whereas, if, instead of arresting the limb at its first position, its motion be allowed to continue, and a lateral force be impressed to make it diverge towards the second position, a curvilinear motion is the necessary result; and by making use of the original momentum, force is economized.

If the truth of these conclusions respecting graceful movements be admitted, it cannot, I think, be doubted, that graceful form is that kind of form which implies relatively small effort required for self-support, and relatively small effort required for movement. Were it otherwise, there would arise the incongruity that graceful form would either not be associated at all with graceful movement, or that the one would habitually occur in the absence of the other; both which alternatives being at variance with our experience, we must conclude that there exists the relationship indicated. Any one hesitating to admit this, will, I think, do so no longer on remembering that the animals which we consider graceful, are those so slight in build as not to be burdened by their own weight, and those noted for fleetness and agility; while those we class as ungraceful, are those which are alike cumbrous and have the faculty of locomotion but little developed. In the case of the greyhound, especially, we see that the particular modification of the canine type in which economy of weight is the most conspicuous, and in which the facility of muscular motion has been brought to the greatest perfection, is the one which we call most graceful.

How trees and inanimate objects should come to have this epithet applied to them, seems less obvious. But remembrance of the fact that we commonly, and perhaps unavoidably, regard all objects under a certain anthropomorphic aspect, will help us to understand it. The stiff branch of an oak tree standing out at right angles to the trunk, gives us a vague notion of great force expended to

keep it in that position; and we call it ungraceful, under the same feeling that we call the holding out an arm at right angles to the body ungraceful. Conversely, the lax drooping boughs of a weeping-willow are vaguely associated with limbs in attitudes requiring little effort to maintain them; and the term graceful, by which we describe these, we apply by metaphor to the boughs of the willow.

I may as well here venture the hypothesis, that the idea of Grace as displayed by other beings, has its subjective basis in Sympathy. The same faculty which makes us shudder on seeing another in danger—which sometimes causes motions of our own limbs on seeing another struggle or fall, gives us a vague participation in all the muscular sensations which those around us are experiencing. When their motions are violent or awkward, we feel in a slight degree the disagreeable sensations which we should have were they our own. When they are easy, we sympathize with the pleasant sensations they imply in those exhibiting them.

PERSONAL BEAUTY.

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It is a common opinion that beauty of character and beauty of aspect are unrelated. I have never been able to reconcile myself to this opinion. Indeed, even those who hold it do so in an incomplete sense; for notwithstanding their theory they continue to manifest surprise when they find a mean deed committed by one of noble countenance—a fact implying that underneath their professed induction lies a still living conviction at variance with it.

Whence this conviction? How is it that a belief in the connexion between worth and beauty primarily exists in all? It cannot be innate. Must it not, then, be from early experiences? And must it not be that in those who continue to believe in this connexion, spite of their reasonings, the early and wide experiences outweigh the later and exceptional ones?

Those who do not admit the relationship between mental and facial beauty, usually remark that the true connexion is between character and expression. While they doubt, or rather deny, that the *permanent* forms of the features are

in any way indices of the forms of the mind, they assert that the *transitory* forms of the features are such indices. These positions seem scarcely consistent. For may we not say that the transitory forms, by perpetual repetition, register themselves on the face, and *produce* permanent forms? Does not an habitual frown by-and-by leave ineffaceable marks on the brow? Is not a chronic scornfulness presently followed by a modified set in the angles of the mouth? Does not that compression of the lips significant of great determination, often stereotype itself; and so give a changed form to the lower part of the face? And if there be any truth in the doctrine of hereditary transmission, must there not be a tendency to the re-appearance of these modifications as new types of feature in the offspring? In brief, may we not say that *expression is feature in the making;* and that if expression means something, the form of feature produced by it means something?

Possibly it will be urged, in reply, that changes of expression affect only the muscles and skin of the face; that the permanent marks they produce can extend but to these; that, nevertheless, the beauty of a face is mainly dependent upon the form of its bony framework; that hence, in this chief respect, there cannot take place such modifications as those described; and that, therefore, the relationship of aspect to character, while it may hold in the details, does not hold in the generals.

The rejoinder is, that the framework of the face *is* modified by modifications in the tissues which cover it. It is an established doctrine in physiology, that throughout the skeleton the greater or less development of bones is dependent on the greater or less development of the attached muscles; that is, on the exercise of them. Hence, permanent changes in the muscular adjustments of the face will be followed by permanent changes in its osseous structure.

Not to dwell in general statements, however, let me cite cases in which the connexion between organic ugliness and

mental inferiority, and the converse connexion between organic beauty and comparative perfection of mind, are distinctly traceable.

It will be admitted that the projecting jaw, characteristic of the lower human races, is a facial defect—is a trait which no sculptor would give to an ideal bust. At the same time, it is a fact that prominence of jaw is associated in the mammalia generally with comparative lack of intelligence. This relationship, it is true, does not hold uniformly. It is not a direct but an indirect one; and is thus liable to be disturbed. Nevertheless, it holds among the higher tribes; and on inquiry we shall see why it holds. In conformity with the law that organs develop in proportion as they are exercised, the jaws are relatively large where the demands made on them are great; and diminish in size as their functions become less numerous and less onerous. Now, in the lower mammals the jaws are the sole organs of manipulation—are used not only for mastication, but for seizing, carrying, gnawing, and, indeed, for everything save locomotion, which is the solitary office performed by the limbs. Advancing upwards, we find that the fore-limbs begin to aid the jaws, and gradually to relieve them of part of their duties. Some creatures use them for burrowing; some, as the felines, for striking; many, to keep steady the prey they are tearing; and when we arrive at the monkeys, whose fore-limbs possess such power of prehension that objects can not only be seized, but carried and pulled to pieces by them, we see that the jaws have fewer functions. Accompanying this series of changes, we see a double change in the form of the head. The increased complexity of the limbs, the greater variety of actions they perform, and the more numerous perceptions they give, imply a greater development of the brain and of its bony envelope. At the same time, the size of the jaws has diminished in correspondence with the diminution of their functions. And by this simultaneous protrusion of the upper part of the cranium

and recession of its lower part, what is called the *facial angle* has increased.

Well, these co-ordinate changes in functions and forms have continued during the civilization of the human race. On contrasting the European and the Papuan, we see that what the one cuts in two with knife and fork, the other tears with his jaws; what the one softens by cooking, the other eats in its hard, raw state; the bones which the one utilises by stewing, the other gnaws; and for sundry of the mechanical manipulations which the one has tools for, the other uses his teeth. From the Bushman state upwards, there has been a gradual increase in the complexity of our appliances. We not only use our hands to save our jaws, but we make implements to save our hands; and in our engine-factories may be found implements for the making of implements. This progression in the arts of life has had intellectual progression for its necessary correlative. Each new complication requires a new increment of intelligence for its production; and the daily use of it develops the intelligence still further. Thus that simultaneous protrusion of the brain and recession of the jaws, which among lower animals has accompanied increase of skill and sagacity, has continued during the advance of Humanity from barbarism to civilization; and has been, throughout, the result of a discipline involving increase of mental power. And so it becomes manifest that there exists an organic relationship between that protuberance of the jaws which we consider ugly, and a certain inferiority of nature.

Again, that lateral jutting-out of the cheek-bones, which similarly characterizes the lower races of men, and which is similarly thought by us a detraction from beauty, is similarly related to lower habits and lower intelligence. The chief agents in closing the jaws are the temporal muscles; and these are consequently the chief active agents in biting and mastication. In proportion as the jaws have much work, and correspondingly large size, must the temporal muscles

be massive. But the temporal muscles pass between the skull and the zygomatic arches, or lateral parts of the cheek-bones. Consequently, where the temporal muscles are massive, the spaces between the zygomatic arches and the skull must be great; and the lateral projection of the zygomatic arches great also, as we see it in the uncivilized and partially civilized races. Like large jaws, therefore, of which it is an accompaniment, excessive size of the cheek-bones is both an ugliness and an index of imperfection.

Certain other defects of feature, between which and mental defects it is not thus easy to trace the connexion, may yet be fairly presumed to have such connexion in virtue of their constant co-existence with the foregoing ones: alike in the uncivilized races and in the young of the civilized races. Peculiarities of face which we find regularly associated with those just shown to be significant of intellectual inferiority, and which like them disappear as barbarism grows into civilization, may reasonably be concluded to have like them a psychological meaning. Thus is it with depression of the bridge of the nose; which is a characteristic both of barbarians and of our babes, possessed by them in common with the higher quadrumana. Thus, also, is it with that forward opening of the nostrils, which renders them conspicuous in a front view of the face —a trait alike of infants, savages, and apes. And the same may be said of wide-spread alæ to the nose, of great width between the eyes, of long mouth, of large mouth,—indeed of all those leading peculiarities of feature which are by general consent called ugly.

And then mark how, conversely, the type of face usually admitted to be the most beautiful, is one that possesses opposite peculiarities. In the ideal Greek head, the forehead projects so much, and the jaws recede so much, as to render the facial angle larger than we ever find it in fact. The cheek-bones are so small as scarcely to be traceable. The bridge of the nose is so high as to be almost or quite in

a line with the forehead. The alæ of the nose join the face with but little obliquity. In the front view the nostrils are almost invisible. The mouth is small, and the upper lip short and deeply concave. The outer angles of the eyes, instead of keeping the horizontal line, as is usual, or being directed upwards, as in the Mongolian type, are directed slightly downwards. And the form of the brow indicates an unusually large frontal sinus—a characteristic entirely absent in children, in the lowest of the human races, and in the allied genera of the *primates*.

If, then, recession of the forehead, protuberance of the jaws, and largeness of the cheek-bones, three leading elements of ugliness, are demonstrably indicative of mental inferiority—if such other facial defects as great width between the eyes, flatness of the nose, spreading of its alæ, frontward opening of the nostrils, length of the mouth, and largeness of the lips, are habitually associated with these, and disappear along with them as intelligence increases, both in the race and in the individual; is it not a fair inference that all such faulty traits of feature signify deficiencies of mind? If, further, our ideal of human beauty is characterized not simply by the absence of these traits, but by the presence of opposite ones—if this ideal, as found in sculptures of the Greek gods, has been used to represent superhuman power and intelligence—and if the race so using it were themselves distinguished by a mental superiority, which, if we consider their disadvantages, produced results unparalleled; have we not yet stronger reasons for concluding that the chief components of beauty and ugliness are severally connected with perfection and imperfection of mental nature? And when, lastly, we remember that the variations of feature constituting expression are confessedly significant of character—when we remember that these tend by repetition to organize themselves, to affect not only the skin and muscles but the bones of the face, and to be transmitted to offspring—when we thus find that there is a

psychological meaning alike in each passing adjustment of the features, in the marks that habitual adjustments leave, in the marks inherited from ancestors, and in those main outlines of the facial bones and integuments indicating the type or race; are we not almost forced to the conclusion that all forms of feature are related to forms of mind, and that we consider them admirable or otherwise according as the traits of nature they imply are admirable or otherwise? In the extremes the relationship is demonstrable. That transitory aspects of face accompany transitory mental states, and that we consider these aspects ugly or beautiful according as the mental states they accompany are ugly or beautiful, no one doubts. That those permanent and most marked aspects of face dependent on the bony framework, accompany those permanent and most marked mental states which express themselves in barbarism and civilization; and that we consider as beautiful those which accompany mental superiority, and as ugly those which accompany mental inferiority, is equally certain. And if this connexion unquestionably holds in the extremes—if, as judged by average facts, and by our half-instinctive convictions, it also holds more or less visibly in intermediate cases, it becomes an almost irresistible induction, that the aspects which please us are the outward correlatives of inward perfections, while the aspects which displease us are the outward correlatives of inward imperfections.

I am quite aware that when tested in detail this induction seems not to be borne out. I know that there are often grand natures behind plain faces; and that fine countenances frequently hide small souls. But these anomalies do not destroy the general truth of the law, any more than the perturbations of planets destroy the general ellipticity of their orbits. Some of them, indeed, may be readily accounted for. There are many faces spoiled by the misproportion of features that are in themselves good; others, by defects of skin, which, though they indicate defects of

visceral constitution, have no relationship to the higher parts of the nature. Moreover the facts that have been assigned afford reason for thinking that the leading elements of facial beauty are not directly associated with *moral* characteristics, but with *intellectual* ones—are the results of long-continued civilized habits, long cessation of domestic barbarism, long culture of the manipulative powers; and so may co-exist with emotional traits not at all admirable. It is true that the highest intellectual manifestations imply a good balance of the higher feelings; but it is also true that great quickness, great sagacity in ordinary affairs, great practical skill, can be possessed without these, and very frequently are so. The prevalent beauty of the Italians, co-existing though it does with a low moral state, becomes, on this hypothesis, reconcileable with the general induction; as do also many of the anomalies we see around us.

There is, however, a more satisfactory explanation to be offered than any of these—an explanation which I think renders it possible to admit the seeming contradictions which the detailed facts present, and yet to hold by the theory. But as more space will be required for showing this than can here be spared, I must defer going further until next week. In the meantime, my own conviction may be expressed in a formula in which I have often before uttered it:—The saying that beauty is but skin-deep, is but a skin-deep saying.

II.

All the civilized races, and probably also the uncivilized ones, are of mixed origin; and, as a consequence, have physical and mental constitutions in which are mingled several aboriginal constitutions more or less differing from each other. This heterogeneity of constitution seems to me the chief cause of the incongruities between aspect and nature which we daily meet with. Given a pure race, subject to constant conditions of climate, food, and habits

of life, and there is reason to believe that between external appearance and internal structure there will be a constant connexion. Unite this race with another equally pure, but adapted to different conditions and having a correspondingly different physique, face, and mind, and there will occur in the descendants, not a homogeneous mean between the two constitutions, but a seemingly irregular combination of characteristics of the one with characteristics of the other—one feature traceable to this race, a second to that, and a third uniting the attributes of both; while in disposition and intellect there will be found a like medley of the two originals.

The fact that the forms and qualities of any offspring are not a mean between the forms and qualities of its parents, but a mixture of them, is illustrated in every family. The features and peculiarities of a child are separately referred by observers to father and mother respectively—nose and mouth to this side; colour of the hair and eyes to that—this moral peculiarity to the first; this intellectual one to the second—and so with contour and idiosyncrasies of body. Manifestly if each organ or faculty in a child was an average of the two developments of such organ or faculty in the parents, it would follow that all brothers and sisters should be alike; or should, at any rate, differ no more than their parents differed from year to year. So far however, from finding this to be the case, we find not only that great irregularities are produced by mixture of traits, but that there is no constancy in the mode of mixture, or the extent of variation produced by it.

This imperfect union of parental constitutions in the constitutions of offspring, is still more clearly illustrated by the re-appearance of peculiarities traceable to bygone generations. Forms, dispositions, and diseases, possessed by distant progenitors, habitually come out from time to time in descendants. Some single feature, or some solitary tendency, will again and again show itself, after being apparently lost. It is notoriously thus with gout, scrofula,

and insanity. On some of the monumental brasses in our old churches are engraved heads having traits still persistent in the same families. Wherever, as in portrait galleries, a register of ancestral faces has been kept, the same fact is more or less apparent. The pertinacity with which particular characteristics re-produce themselves is well exemplified in America, where traces of negro blood can be detected in the finger nails, when no longer visible in the complexion. Among breeders of animals it is well known that, after several generations in which no visible modifications were traceable, the effects of a cross will suddenly make their appearance. In all which facts we see the general truth that an organism produced from two organisms constitutionally different, is not a homogeneous mean; but is made up of components, taken in variable ways and proportions from the originals.

In a recent number of the *Quarterly Journal of the Agricultural Society* were published some facts respecting the mixture of French and English races of sheep, bearing collaterally on this point. Sundry attempts had been made to improve the poor French breeds by our fine English ones. For a long time these attempts failed. The hybrids bore no trace of their English male ancestry; but were as dwarfed and poverty-stricken as their French dams. Eventually the cause of failure was found to lie in the relative heterogeneity and homogeneity of the two constitutions. The superior English sheep were of mixed race; the French sheep, though inferior, were of pure race; and the compound, imperfectly co-ordinated constitution of the one could not maintain itself against the simple and completely balanced constitution of the other. This, at first an hypothesis, was presently demonstrated. French sheep of mixed constitution having been obtained by uniting two of the pure French breeds, it was found that these hybrid French sheep, when united with the English ones, produced a cross in which the English characteristics were duly dis-

played. Now, this inability of a mixed constitution to stand its ground against an unmixed one, quite accords with the above induction. An unmixed constitution is one in which all the organs are exactly fitted to each other—are perfectly balanced: the system as a whole, is in stable equilibrium. A mixed constitution, on the contrary, being made up of organs belonging to two separate sets, cannot have them in exact fitness—cannot have them perfectly balanced; and a system in comparatively unstable equilibrium results. But in proportion to the stability of the equilibrium will be the power to resist disturbing forces. Hence, when two constitutions, in stable and unstable equilibrium respectively, become disturbing forces to each other, the unstable one will be overthrown, and the stable one will assert itself unchanged.

The imperfect co-ordination of parts in a mixed constitution, and this consequent instability of its equilibrium, are intimately connected with the vexed question of genera, species, and varieties; and, with a view partly to the intrinsic interest of this question, and partly to the further elucidation of the topic in hand, I must again digress.

The current physiological test of distinct species is the production of a non-prolific hybrid. The ability of the offspring to reproduce itself is held to indicate that its parents are of the same species, however widely they may differ in appearance; and its inability to do this is taken as proof that, nearly allied as its parents may seem, they are distinct in kind. Of late, however, facts have been accumulating that tend more and more to throw doubt on this generalization. Cattle-breeders have established it as a general fact, that the offspring of two different breeds of sheep or oxen dwindle away in a few generations if allied with themselves; and that a good result can be obtained only by mixing them with one or other of the original breeds—a fact implying that what is true of so-called species, is, under a modified form, true of varieties also.

The same phenomena are observable in the mixtures of different races of men. They, too, it is alleged, cannot maintain themselves as separate varieties; but die out unless there is intermarriage with the originals. In brief, it seems that the hybrids produced from two distinct races of organisms may die out in the first, second, third, fourth, fifth, &c., generation, according as the constitutional difference of the races is greater or less. Now, the experience of the French sheep-breeders, above-quoted, suggests a rationale of these various results. For if it be true that an organism produced by two unlike organisms is not a mean between them, but a mixture of parts of the one with parts of the other—if it be true that these parts belonging to two different sets are of necessity imperfectly co-ordinated; then it becomes manifest that in proportion as the difference between the parent organisms is greater or less, the defects of co-ordination in the offspring will be greater or less. Whence it follows that, according to the degree of organic incongruity between the parents, we may have every gradation in the offspring, from a combination of parts so incongruous that it will not work at all, up to a combination complete enough to subsist permanently as a race. And this is just what we find in fact. Between organisms widely differing in character, no intermediate organism is possible. When the difference is less, a non-prolific hybrid is produced—an organism so ill co-ordinated as to be capable only of incomplete life. When the difference is still less, there results an organism capable of reproducing itself; but not of bequeathing to its offspring complete constitutions. And as the degrees of difference are further diminished, the incompleteness of constitution is longer and longer in making its appearance; until we come to those varieties of the same species which differ so slightly that their offspring are as permanent as themselves. Even in these, however, the organic equilibrium seems less perfect; as is illustrated

in the case I have quoted. And in connexion with this inference, it would be interesting to inquire whether pure constitutions are not superior to mixed ones, in their power of maintaining the balance of vital functions under disturbing conditions. Is it not a fact, that the pure breeds are *hardier* than the mixed ones? Are not the mixed ones, though superior in size, less capable of resisting unfavourable influences—extremes of temperature, bad food, &c.? And is not the like true of mankind?

Returning to the topic in hand, it is manifest that these facts and reasonings serve further to enforce the general truth, that the offspring of two organisms not identical in constitution is a heterogeneous mixture of the two, and not a homogeneous mean between them.

If, then, bearing in mind this truth, we remember the composite character of the civilized races—the mingling in ourselves, for example, of Celt, Saxon, Norman, Dane, with sprinklings of other tribes; if we consider the complications of constitution that have arisen from the unions of these, not in any uniform manner, but with utter irregularity; and if we recollect that the incongruities thus produced pervade the whole nature, mental and bodily—nervous tissue and other tissues; we shall see that there must exist in all of us an imperfect correspondence between parts of the organism that are really related; and that as one manifestation of this, there must be more or less of discrepancy between the features and those parts of the nervous system with which they have a physiological connexion.

If this be so, then the difficulties which stand in the way of the belief that beauty of character is related to beauty of face are considerably diminished. It becomes possible to admit that plainness may co-exist with nobility of nature, and fine features with baseness; and yet to hold that mental and facial perfection are fundamentally connected, and will, when the present causes of incongruity have worked themselves out, be ever found united.

THE ORIGIN AND FUNCTION OF MUSIC.

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When Carlo, standing, chained to his kennel, sees his master in the distance, a slight motion of the tail indicates his but faint hope that he is about to be let out. A much more decided wagging of the tail, passing by-and-by into lateral undulations of the body, follows his master's nearer approach. When hands are laid on his collar, and he knows that he is really to have an outing, his jumping and wriggling are such that it is by no means easy to loose his fastenings. And when he finds himself actually free, his joy expends itself in bounds, in pirouettes, and in scourings hither and thither at the top of his speed. Puss, too, by erecting her tail, and by every time raising her back to meet the caressing hand of her mistress, similarly expresses her gratification by certain muscular actions; as likewise do the parrot by awkward dancings on his perch, and the canary by hopping and fluttering about his cage with unwonted rapidity. Under emotions of an opposite kind, animals equally display muscular excitement. The enraged lion lashes his sides with his tail, knits his brows, protrudes his claws. The cat sets up her back; the dog retracts his upper lip; the horse throws back his ears. And in the struggles of creatures in pain, we see that a like relation

holds between excitement of the muscles and excitement of the nerves of sensation.

In ourselves, distinguished from lower creatures by feelings alike more powerful and more varied, parallel facts are at once more conspicuous and more numerous. Let us look at them in groups. We shall find that pleasurable sensations and painful sensations, pleasurable emotions and painful emotions, all tend to produce active demonstrations in proportion to their intensity.

In children, and even in adults who are not restrained by regard for appearances, a highly agreeable taste is followed by a smacking of the lips. An infant will laugh and bound in its nurse's arms at the sight of a brilliant colour or the hearing of a new sound. People are apt to beat time with head or feet to music which particularly pleases them. In a sensitive person an agreeable perfume will produce a smile; and smiles will be seen on the faces of a crowd gazing at some splendid burst of fireworks. Even the pleasant sensation of warmth felt on getting to the fireside out of a winter's storm, will similarly express itself in the face.

Painful sensations, being mostly far more intense than pleasurable ones, cause muscular actions of much more decided kinds. A sudden twinge produces a convulsive start of the whole body. A pain less violent, but continuous, is accompanied by a knitting of the brows, a setting of the teeth or biting of the lip, and a contraction of the features generally. Under a persistent pain of a severer kind, other muscular actions are added: the body is swayed to and fro; the hands clench anything they can lay hold of; and should the agony rise still higher, the sufferer rolls about on the floor almost convulsed.

Though more varied, the natural language of the pleasurable emotions comes within the same generalization. A smile, which is the commonest expression of gratified feeling, is a contraction of certain facial muscles; and when the smile broadens into a laugh, we see a more violent and

more general muscular excitement produced by an intenser gratification. Rubbing together of the hands, and that other motion which Hood describes as the washing of "hands with invisible soap in imperceptible water," have like implications. Children may often be seen to "jump for joy." Even in adults of excitable temperament, an action approaching to it is sometimes witnessed. And dancing has all the world through been regarded as natural to an elevated state of minds. Many of the special emotions show themselves in special muscular actions. The gratification resulting from success, raises the head and gives firmness to the gait. A hearty grasp of the hand is currently taken as indicative of friendship. Under a gush of affection the mother clasps her child to her breast, feeling as though she could squeeze it to death. And so in sundry other cases. Even in that brightening of the eye with which good news is received we may trace the same truth; for this sparkling appearance is due to an extra contraction of the muscle which raises the eyelid, and so allows more light to fall upon, and be reflected from, the wet surface of the eyeball.

The bodily indications of painful emotion are equally numerous, and still more vehement. Discontent is shown by raised eyebrows and wrinkled forehead; disgust by a curl of the lip, offence by a pout. The impatient man beats a tattoo with his fingers on the table, swings his pendant leg with increasing rapidity, gives needless pokings to the fire, and presently paces with hasty strides about the room. In great grief there is wringing of the hands, and even tearing of the hair. An angry child stamps, or rolls on its back and kicks its heels in the air; and in manhood, anger, first showing itself in frowns, in distended nostrils, in compressed lips, goes on to produce grinding of the teeth, clenching of the fingers, blows of the fist on the table, and perhaps ends in a violent attack on the offending person, or in throwing about and breaking the furniture. From

that pursing of the mouth indicative of slight displeasure, up to the frantic struggles of the maniac, we find that mental irritation tends to vent itself in bodily activity.

All feelings, then—sensations or emotions, pleasurable or painful—have this common characteristic, that they are muscular stimuli. Not forgetting the few apparently exceptional cases in which emotions exceeding a certain intensity produce prostration, we may set it down as a general law, that alike in man and animals, there is a direct connexion between feeling and movement; the last growing more vehement as the first grows more intense. Were it allowable here to treat the matter scientifically, we might trace this general law down to the principle known among physiologists as that of *reflex action*.* Without doing this, however, the above numerous instances justify the generalization that every kind of mental excitement ends in excitement of the muscles; and that the two preserve a more or less constant ratio to each other.

"But what has all this to do with *The Origin and Function of Music?*" asks the reader. Very much, as we shall presently see. All music is originally vocal. All vocal sounds are produced by the agency of certain muscles. These muscles, in common with those of the body at large, are excited to contraction by pleasurable and painful feelings. And therefore it is that feelings demonstrate themselves in sounds as well as in movements. Therefore it is that Carlo barks as well as leaps when he is let out—that puss purrs as well as erects her tail—that the canary chirps as well as flutters. Therefore it is that the angry lion roars while he lashes his sides, and the dog growls while he retracts his lip. Therefore it is that the maimed animal not only struggles, but howls. And it is from this cause that in human beings bodily suffering expresses itself not only in

* Those who seek information on this point may find it in an interesting tract by Mr. Alexander Bain, on *Animal Instinct and Intelligence*.

contortions, but in shrieks and groans—that in anger, and fear, and grief, the gesticulations are accompanied by shouts and screams—that delightful sensations are followed by exclamations—and that we hear screams of joy and shouts of exultation.

We have here, then, a principle underlying all vocal phenomena; including those of vocal music, and by consequence those of music in general. The muscles that move the chest, larynx, and vocal chords, contracting like other muscles in proportion to the intensity of the feelings; every different contraction of these muscles involving, as it does, a different adjustment of the vocal organs; every different adjustment of the vocal organs causing a change in the sound emitted;—it follows that variations of voice are the physiological results of variations of feeling. It follows that each inflection or modulation is the natural outcome of some passing emotion or sensation; and it follows that the explanation of all kinds of vocal expression, must be sought in this general relation between mental and muscular excitements. Let us, then, see whether we cannot thus account for the chief peculiarities in the utterance of the feelings: grouping these peculiarities under the heads of *loudness*, *quality or timbre*, *pitch*, *intervals*, and *rate of variation*.

Between the lungs and the organs of voice, there is much the same relation as between the bellows of an organ and its pipes. And as the loudness of the sound given out by an organ-pipe increases with the strength of the blast from the bellows; so, other things equal, the loudness of a vocal sound increases with the strength of the blast from the lungs. But the expulsion of air from the lungs is effected by certain muscles of the chest and abdomen. The force with which these muscles contract, is proportionate to the intensity of the feeling experienced. Hence, *a priori*, loud sounds will be the habitual results of strong feelings. That they are so we have daily proof. The pain which,

if moderate, can be borne silently, causes outcries if it becomes extreme. While a slight vexation makes a child whimper, a fit of passion calls forth a howl that disturbs the neighbourhood. When the voices in an adjacent room become unusually audible, we infer anger, or surprise, or joy. Loudness of applause is significant of great approbation; and with uproarious mirth we associate the idea of high enjoyment. Commencing with the silence of apathy, we find that the utterances grow louder as the sensations or emotions, whether pleasurable or painful, grow stronger.

That different *qualities* of voice accompany different mental states, and that under states of excitement the tones are more sonorous than usual, is another general fact admitting of a parallel explanation. The sounds of common conversation have but little resonance; those of strong feeling have much more. Under rising ill temper the voice acquires a metallic ring. In accordance with her constant mood, the ordinary speech of a virago has a piercing quality quite opposite to that softness indicative of placidity. A ringing laugh marks joyous temperament. Grief, unburdening itself, uses tones approaching in *timbre* to those of chanting; and in his most pathetic passages an eloquent speaker similarly falls into tones more vibratory than those common to him. Now any one may readily convince himself that resonant vocal sounds can be produced only by a certain muscular effort additional to that ordinarily needed. If after uttering a word in his speaking voice, the reader, without changing the pitch or the loudness, will *sing* this word, he will perceive that before he can sing it, he has to alter the adjustment of the vocal organs; to do which a certain force must be used; and by putting his fingers on that external prominence marking the top of the larynx, he will have further evidence that to produce a sonorous tone the organs must be drawn out of their usual position. Thus, then, the fact that the tones of excited feeling are more vibratory than those of common conversa-

tion, is another instance of the connexion between mental excitement and muscular excitement. The speaking voice, the recitative voice, and the singing voice, severally exemplify one general principle.

That the *pitch* of the voice varies according to the action of the vocal muscles, scarcely needs saying. All know that the middle notes, in which they converse, are made without appreciable effort; and all know that to make either very high notes or very low notes requires considerable effort. In either ascending or descending from the pitch of ordinary speech, we are conscious of increasing muscular strain, which, at each extreme of the register, becomes painful. Hence it follows from our general principle, that while indifference or calmness will use the medium tones, the tones used during excitement will be either above or below them; and will rise higher and higher, or fall lower and lower, as the feelings grow stronger. This physiological deduction we also find to be in harmony with familiar facts. The habitual sufferer utters his complaints in a voice raised considerably above the natural key; and agonizing pain vents itself in either shrieks or groans—in very high or very low notes. Beginning at his talking pitch, the cry of the disappointed urchin grows more shrill as it grows louder. The "Oh!" of astonishment or delight, begins several notes below the middle voice, and descends still lower. Anger expresses itself in high tones, or else in "curses not loud but *deep*." Deep tones, too, are always used in uttering strong reproaches. Such an exclamation as "Beware!" if made dramatically—that is, if made with a show of feeling—must be many notes lower than ordinary. Further, we have groans of disapprobation, groans of horror, groans of remorse. And extreme joy and fear are alike accompanied by shrill outcries.

Nearly allied to the subject of pitch, is that of *intervals*; and the explanation of them carries our argument a step

further. While calm speech is comparatively monotonous, emotion makes use of fifths, octaves, and even wider intervals. Listen to any one narrating or repeating something in which he has no interest, and his voice will not wander more than two or three notes above or below his medium note, and that by small steps; but when he comes to some exciting event he will be heard not only to use the higher and lower notes of his register, but to go from one to the other by larger leaps. Being unable in print to imitate these traits of feeling, we feel some difficulty in fully conveying them to the reader. But we may suggest a few remembrances which will perhaps call to mind a sufficiency of others. If two men living in the same place, and frequently seeing one another, meet, say at a public assembly, any phrase with which one accosts the other—as "Hallo, are you here?"—will have an ordinary intonation. But if one of them, after a long absence, has unexpectedly returned, the expression of surprise with which his friend greets him—"Hallo! how came you here?"—will be uttered in much more strongly contrasted tones. The two syllables of the word "Hallo" will be, the one much higher and the other much lower than before; and the rest of the sentence will similarly ascend and descend by longer steps. Again, if, supposing her maid to be in an adjoining room, the mistress of the house calls "Mary," the two syllables of the name will be spoken in an ascending interval of a third If Mary does not reply, the call will be repeated probably in a descending fifth; implying the slightest shade of annoyance at Mary's inattention. Should Mary still make no answer, the increasing annoyance will show itself by the use of a descending octave on the next repetition of the call. And supposing the silence to continue, the lady, if not of a very even temper, will show her irritation at Mary's seemingly intentional negligence by finally calling her in tones still more widely contrasted—the first syllable

being higher and the last lower than before. Now, these and analogous facts, which the reader will readily accumulate, clearly conform to the law laid down. For to make large intervals requires more muscular action than to make small ones. But not only is the *extent* of vocal intervals thus explicable as due to the relation between nervous and muscular excitement, but also, in some degree, their *direction*, as ascending or descending. The middle notes being those which demand no appreciable effort of muscular adjustment; and the effort becoming greater as we either ascend or descend; it follows that a departure from the middle notes in either direction will mark increasing emotion; while a return towards the middle notes will mark decreasing emotion. Hence it happens that an enthusiastic person, uttering such a sentence as—"It was the most splendid sight I ever saw!" will ascend to the first syllable of the word "splendid," and thence will descend: the word "splendid" marking the climax of the feeling produced by the recollection. Hence, again, it happens that, under some extreme vexation produced by another's stupidity, an irascible man, exclaiming—"What a confounded fool the fellow is!" will begin somewhat below his middle voice, and descending to the word "fool," which he will utter in one of his deepest notes, will then ascend. And it may be remarked, that the word "fool" will not only be deeper and louder than the rest, but will also have more emphasis of articulation—another mode in which muscular excitement is shown. There is some danger, however, in giving instances like this; seeing that as the mode of rendering will vary according to the intensity of the feeling which the reader feigns to himself, the right cadence may not be hit upon. With single words there is less difficulty. Thus the "Indeed!" with which a surprising fact is received, mostly begins on the middle note of the voice, and rises with the second syllable; or, if disapprobation as well as astonishment is felt, the

first syllable will be below the middle note, and the second lower still. Conversely, the word "Alas!" which marks not the rise of a paroxysm of grief, but its decline, is uttered in a cadence descending towards the middle note; or, if the first syllable is in the lower part of the register, the second ascends towards the middle note. In the "Heigh-ho!" expressive of mental or muscular prostration, we may see the same truth; and if the cadence appropriate to it be inverted, the absurdity of the effect clearly shows how the meaning of intervals is dependent on the principle we have been illustrating.

The remaining characteristic of emotional speech which we have to notice, is that of *variability of pitch*. It is scarcely possible here to convey adequate ideas of this more complex manifestation. We must be content with simply indicating some occasions on which it may be observed. On a meeting of friends, for instance—as when there arrives a party of much-wished-for visitors—the voices of all will be heard to undergo changes of pitch not only greater but much more numerous than usual. If a speaker at a public meeting is interrupted by some squabble among those he is addressing, his comparatively level tones will be in marked contrast with the rapidly changing ones of the disputants. And among children, whose feelings are less under control than those of adults, this peculiarity is still more decided. During a scene of complaint and recrimination between two excitable little girls, the voices may be heard to run up and down the gamut several times in each sentence. In such cases we once more recognize the same law: for muscular excitement is shown not only in strength of contraction, but also in the rapidity with which different muscular adjustments succeed one another.

Thus we find all the leading vocal phenomena to have a physiological basis. They are so many manifestations of the general law that feeling is a stimulus to muscular

action—a law conformed to throughout the whole economy, not of man only, but of every sensitive creature—a law, therefore, which lies deep in the nature of animal organization. The expressiveness of these various modifications of voice is therefore innate. Each of us, from babyhood upwards, has been spontaneously making them, when under the various sensations and emotions by which they are produced. Having been conscious of each feeling at the same time that we heard ourselves make the consequent sound, we have acquired an established association of ideas between such sound and the feeling which caused it. When the like sound is made by another, we ascribe the like feeling to him; and by a further consequence we not only ascribe to him that feeling, but have a certain degree of it aroused in ourselves: for to become conscious of the feeling which another is experiencing, is to have that feeling awakened in our own consciousness, which is the same thing as experiencing the feeling. Thus these various modifications of voice become not only a language through which we understand the emotions of others, but also the means of exciting our sympathy with such emotions.

Have we not here, then, adequate data for a theory of music? These vocal peculiarities which indicate excited feeling, *are those which especially distinguish song from ordinary speech.* Every one of the alterations of voice which we have found to be a physiological result of pain or pleasure, *is carried to an extreme in vocal music.* For instance, we saw that, in virtue of the general relation between mental and muscular excitement, one characteristic of passionate utterance is *loudness.* Well, its comparative loudness is one of the distinctive marks of song as contrasted with the speech of daily life. Though there are *piano* passages in contrast with the *forte* passages, yet the average loudness of the singing voice is much greater than

that of the speaking voice; and further, the *forte* passages of an air are those intended to represent the climax of its emotion. We next saw that the tones in which emotion expresses itself, are, in conformity with this same law, of a more sonorous *timbre* than those of calm conversation. Here, too, song displays a still higher degree of the peculiarity; for the singing tone is the most resonant we can make. Again, it was shown that, from a like cause, mental excitement vents itself in the higher and lower notes of the register; using the middle notes but seldom. And it scarcely needs saying that vocal music is still more distinguished by its comparative neglect of the notes in which we talk, and its habitual use of those above or below them; and, moreover, that its most passionate effects are commonly produced at the two extremities of its scale, but especially at the upper one. A yet further trait of strong feeling, similarly accounted for, was the habitual employment of larger intervals than are employed in common converse. This trait, also, every ballad and *aria* systematically elaborates: add to which, that the direction of these intervals, which, as diverging from or converging towards the medium tones, we found to be physiologically expressive of increasing or decreasing emotion, may be observed to have in music like meanings. Once more, it was pointed out that not only extreme but also rapid variations of pitch, are characteristic of mental excitement; and once more we see in the quick changes of every melody, that song carries the characteristic as far, if not farther. Thus, in respect alike of *loudness*, *timbre*, *pitch*, *intervals*, and *rate of variation*, song employs and exaggerates the natural language of the emotions;—it arises from a systematic combination of those vocal peculiarities which are the physiological effects of acute pleasure and pain.

Besides these chief characteristics of song as distinguished from common speech, there are sundry minor ones

similarly explicable as due to the relation between mental and muscular excitement; and before proceeding further, these should be briefly noticed. Thus, certain passions, and perhaps all passions when pushed to an extreme, produce (probably through their influence over the action of the heart) an effect the reverse of that which has been described: they cause a physical prostration, one symptom of which is a general relaxation of the muscles, and a consequent trembling. We have the trembling of anger, of fear, of hope, of joy; and the vocal muscles being implicated with the rest, the voice too becomes tremulous. Now, in singing, this tremulousness of voice is effectively used by some vocalists in pathetic passages; sometimes, indeed, because of its effectiveness, too much used by them—as by Tamberlik, for instance. Again, there is a mode of musical execution known as the *staccato*, appropriate to energetic passages—to passages expressive of exhilaration, of resolution, of confidence. The action of the vocal muscles which produces this staccato style, is analogous to the muscular action which produces the sharp, decisive, energetic movements of body indicating these states of mind; and therefore it is that the staccato style has the meaning we ascribe to it. Conversely, slurred intervals are expressive of gentler and less active feelings; and are so because they imply the smaller muscular vivacity due to a lower mental energy. The difference of effect resulting from difference of *time* in music, is also attributable to this same law. Already it has been pointed out that the more frequent changes of pitch which ordinarily result from passion, are imitated and developed in song; and here we have to add, that the various rates of such changes, appropriate to the different styles of music, are further traits having the same derivation. The slowest movements, *largo* and *adagio*, are used where such depressing emotions as grief, or such unexciting emotions as reverence, are to be portrayed; while the more rapid movements, *andante*,

allegro, presto, represent successively increasing degrees of mental vivacity; and do this because they imply that muscular activity which flows from this mental vivacity. Even the *rhythm,* which forms a remaining distinction between song and speech, may not improbably have a kindred cause. Why the actions excited by strong feeling should tend to become rhythmical, is not obvious; but that they do so there are divers evidences. There is the swaying of the body to and fro under pain or grief, of the leg under impatience or agitation. Dancing, too, is a rhythmical action natural to elevated emotion. That under excitement speech acquires a certain rhythm, we may occasionally perceive in the highest efforts of an orator. In poetry, which is a form of speech used for the better expression of emotional ideas, we have this rhythmical tendency developed. And when we bear in mind that dancing, poetry, and music are connate—are originally constituent parts of the same thing, it becomes clear that the measured movement common to them all implies a rhythmical action of the whole system, the vocal apparatus included; and that so the rhythm of music is a more subtle and complex result of this relation between mental and muscular excitement.

But it is time to end this analysis, which possibly we have already carried too far. It is not to be supposed that the more special peculiarities of musical expression are to be definitely explained. Though probably they may all in some way conform to the principle that has been worked out, it is impracticable to trace that principle in its more ramified applications. Nor is it needful to our argument that it should be so traced. The foregoing facts sufficiently prove that what we regard as the distinctive traits of song, are simply the traits of emotional speech intensified and systematized. In respect of its general characteristics, we think it has been made clear that vocal music, and by

consequence all music, is an idealization of the natural language of passion.

As far as it goes, the scanty evidence furnished by history confirms this conclusion. Note first the fact (not properly an historical one, but fitly grouped with such) that the dance-chants of savage tribes are very monotonous; and in virtue of their monotony are more nearly allied to ordinary speech than are the songs of civilized races. Joining with this the fact that there are still extant among boatmen and others in the East, ancient chants of a like monotonous character, we may infer that vocal music originally diverged from emotional speech in a gradual, unobtrusive manner; and this is the inference to which our argument points. From the characters of the intervals the same conclusion may be drawn.

"The songs of savages in the lowest scale of civilization are generally confined to the compass of few notes, seldom extending beyond the interval of the *fifth*. Sometimes, however, a sudden transition into the octave occurs, especially in sudden exclamations, or where a word naturally dictates an emphatic raising of the voice. The *fifth* especially plays a prominent part in primitive vocal music. . . . But it must not be supposed that each interval is distinctly intoned: on the contrary, in the transition from one interval to another, all the intermediate intervals are slightly touched in a way somewhat similar to a violinist drawing his finger rapidly over the string from one note to another to connect them; and as the intervals themselves are seldom clearly defined, it will easily be understood how nearly impossible it is to write down such songs in our notation so as to convey a correct idea of their natural effect."*

Further evidence to the same effect is supplied by Greek history. The early poems of the Greeks—which, be it remembered, were sacred legends embodied in that rhythmical, metaphorical language which strong feeling excites—were not recited, but chanted: the tones and cadences

* *The Music of the Most Ancient Nations, &c.*, by Carl Engel. This quotation is not contained in my essay as originally published, nor in the version of it first reproduced in 1858. Herr Engel's work was issued in 1864, seven years after the date of the essay.

were made musical by the same influences which made the speech poetical. By those who have investigated the matter, this chanting is believed to have been not what we call singing, but nearly allied to our recitative—nearly allied but simpler. Several facts conspire to show this. The earliest stringed instruments had sometimes four, sometimes five strings: Egyptian frescoes delineate some of the simpler harps as thus constituted, and there are kindred representations of the lyres and allied instruments of the Assyrians, Hebrews, Greeks and Romans. That the earliest Greek lyre had but four strings, and that the recitative of the poet was uttered in unison with its sounds, Neumann finds definite proof in a verse ascribed to Terpander, celebrating his introduction of the seven-stringed lyre:—

"The four-tonèd hymns now rejecting,
And yearning for songs new and sweet,
With seven strings softly vibrating,
The lyre anon shall we greet."

Hence it follows that the primitive recitative was simpler than our modern recitative, and, as such, much less remote from common speech than our own singing is. For recitative, or musical recitation, is in all respects intermediate between speech and song. Its average effects are not so *loud* as those of song. Its tones are less sonorous in *timbre* than those of song. Commonly it diverges to a smaller extent from the middle notes—uses notes neither so high nor so low in *pitch*. The *intervals* habitual to it are neither so wide nor so varied. Its *rate of variation* is not so rapid. And at the same time that its primary *rhythm* is less decided, it has none of that secondary rhythm produced by recurrence of the same or parallel musical phrases, which is one of the marked characteristics of song. Thus, then, we may not only infer, from the evidence furnished by existing barbarous tribes, that the vocal music of prehistoric times was emotional speech very slightly exalted; but we see that the earliest vocal music of which we have

any account, differed much less from emotional speech than does the vocal music of our days.

That recitative—beyond which, by the way, the Chinese and Hindoos seem never to have advanced—grew naturally out of the modulations and cadences of strong feeling, we have indeed current evidence. There are even now to be met with occasions on which strong feeling vents itself in this form. Whoever has been present when a meeting of Quakers was addressed by one of their number (whose practice it is to speak only under the influence of religious emotion), must have been struck by the quite unusual tones, like those of a subdued chant, in which the address was made. On passing a chapel in Wales during service, the raised and sing-song voice of the preacher draws the attention. It is clear, too, that the intoning used in churches is representative of this mental state; and has been adopted on account of the congruity between it and the contrition, supplication, or reverence, verbally expressed.

And if, as we have good reason to believe, recitative arose by degrees out of emotional speech, it becomes manifest that by a continuance of the same process song has arisen out of recitative. Just as, from the orations and legends of savages, expressed in the metaphorical, allegorical style natural to them, there sprung epic poetry, out of which lyric poetry was afterwards developed; so, from the exalted tones and cadences in which such orations and legends were delivered, came the chant or recitative music, from which lyrical music has since grown up. And there has not only thus been a simultaneous and parallel genesis, but there has been reached a parallelism of results. For lyrical poetry differs from epic poetry, just as lyrical music differs from recitative: each still further intensifies the natural language of the emotions. Lyrical poetry is more metaphorical, more hyperbolic, more elliptical, and adds the rhythm of lines to the rhythm of feet; just as lyrical music is louder, more sonorous, more extreme in its

intervals, and adds the rhythm of phrases to the rhythm of bars. And the known fact that out of epic poetry the stronger passions developed lyrical poetry as their appropriate vehicle, strengthens the inference that they similarly developed lyrical music out of recitative.

Nor indeed are we without evidences of the transition. It needs but to listen to an opera to hear the leading gradations. Between the comparatively level recitative of ordinary dialogue, the more varied recitative with wider intervals and higher tones used in exciting scenes, the still more musical recitative which preludes an air, and the air itself, the successive steps are but small; and the fact that among airs themselves gradations of like nature may be traced, further confirms the conclusion that the highest form of vocal music was arrived at by degrees.

We have some clue to the influences which have induced this development; and may roughly conceive the process of it. As the tones, intervals, and cadences of strong emotion were the elements out of which song was elaborated; so, we may expect to find that still stronger emotion produced the elaboration; and we have evidence implying this. Musical composers are men of acute sensibilities. The Life of Mozart depicts him as one of intensely active affections and highly impressionable temperament. Various anecdotes represent Beethoven as very susceptible and very passionate. Mendelssohn is described by those who knew him as having been full of fine feeling. And the almost incredible sensitiveness of Chopin has been illustrated in the memoirs of George Sand. An unusually emotional nature being thus the general characteristic of musical composers, we have in it just the agency required for the development of recitative and song. Any cause of excitement will generate just those exaggerations which we have found to distinguish the lower vocal music from emotional speech, and the higher vocal music from the lower. Thus it becomes credible that the four-toned recitative of the

early Greek poets (like all poets, nearly allied to composers in the comparative intensity of their feelings), was really nothing more than the slightly exaggerated emotional speech natural to them, which grew by frequent use into an organized form. And we may infer that the accumulated agency of subsequent poet-musicians, inheriting and adding to the products of those who went before them, sufficed, in the course of many centuries, to develope this simple four-toned recitative into a vocal music having great complexity and range.

Not only may we so understand how more sonorous tones, greater extremes of pitch, and wider intervals, were gradually introduced; but also how there arose a greater variety and complexity of musical expression. For this same passionate, enthusiastic temperament, which leads the musical composer to express the feelings possessed by others as well as himself, in more marked cadences than they would use, also leads him to give musical utterance to feelings which they either do not experience, or experience in but slight degrees. And thus we may in some measure understand how it happens that music not only so strongly excites our more familiar feelings, but also produces feelings we never had before—arouses dormant sentiments of which we do not know the meaning; or, as Richter says—tells us of things we have not seen and shall not see.

Indirect evidences of several kinds remain to be briefly pointed out. One of them is the difficulty, not to say impossibility, of otherwise accounting for the expressiveness of music. Whence comes it that special combinations of notes should have special effects upon our emotions?—that one should give us a feeling of exhilaration, another of melancholy, another of affection, another of reverence? Is it that these special combinations have intrinsic meanings apart from the human constitution?—that a certain number of aërial waves per second, followed by a certain other

number, in the nature of things signify grief, while in the reverse order they signify joy; and similarly with all other intervals, phrases, and cadences? Few will be so irrational as to think this. Is it, then, that the meanings of these special combinations are conventional only?—that we learn their implications, as we do those of words, by observing how others understand them? This is an hypothesis not only devoid of evidence, but directly opposed to the experience of every one; and it is excluded by the fact that children, unconventionalised though they are, show great susceptibility to music. How, then, are musical effects to be explained? If the theory above set forth be accepted, the difficulty disappears. If music, taking for its raw material the various modifications of voice which are the physiological results of excited feeling, intensifies, combines, and complicates them—if it exaggerates the loudness, the resonance, the pitch, the intervals, and the variability, which, in virtue of an organic law, are the characteristics of passionate speech—if, by carrying out these further, more consistently, more unitedly, and more sustainedly, it produces an idealized language of emotion; then its power over us becomes comprehensible. But in the absence of this theory the expressiveness of music appears inexplicable.

Again, the preference we feel for certain qualities of sound presents a like difficulty, admitting only of a like solution. It is generally agreed that the tones of the human voice are more pleasing than any others. If music takes its rise from the modulations of the human voice under emotion, it is a natural consequence that the tones of that voice appeal to our feelings more than any others, and are considered more beautiful than any others. But deny that music has this origin, and the only alternative is the untenable one that the vibrations proceeding from a vocalist's throat are, objectively considered, of a higher order than those from a horn or a violin.

Once more, the question—How is the expressiveness of

music to be otherwise accounted for? may be supplemented by the question—How is the genesis of music to be otherwise accounted for? That music is a product of civilization is manifest; for though some of the lowest savages have their dance-chants, these are of a kind scarcely to be dignified by the title musical: at most, they supply but the vaguest rudiment of music, properly so called. And if music has been by slow steps developed in the course of civilization, it must have been developed out of something. If, then, its origin is not that above alleged, what is its origin?

Thus we find that the negative evidence confirms the positive, and that, taken together, they furnish strong proof. We have seen that there is a physiological relation, common to man and all animals, between feeling and muscular action; that as vocal sounds are produced by muscular action, there is a consequent physiological relation between feeling and vocal sounds; that all the modifications of voice expressive of feeling are the direct results of this physiological relation; that music, adopting all these modifications, intensifies them more and more as it ascends to its higher and higher forms; that, from the ancient epic poet chanting his verses, down to the modern musical composer, men of unusually strong feelings prone to express them in extreme forms, have been naturally the agents of these successive intensifications; and that so there has little by little arisen a wide divergence between this idealized language of emotion and its natural language: to which direct evidence we have just added the indirect—that on no other tenable hypothesis can either the expressiveness of music or the genesis of music be explained.

And now, what is the *function* of music? Has music any effect beyond the immediate pleasure it produces? Analogy suggests that it has. The enjoyments of a good dinner do not end with themselves, but minister to bodily well-being. Though people do not marry with a view to maintain the race, yet the passions which impel them to marry secure its

maintenance. Parental affection is a feeling which, while it conduces to parental happiness, ensures the nurture of offspring. Men love to accumulate property, often without thought of the benefits it produces; but in pursuing the pleasure of acquisition they indirectly open the way to other pleasures. The wish for public approval impels all of us to do many things which we should otherwise not do,—to undertake great labours, face great dangers, and habitually rule ourselves in ways that smooth social intercourse; so that, in gratifying our love of approbation we subserve divers ulterior purposes. And, generally, our nature is such that in fulfilling each desire, we in some way facilitate fulfilment of the rest. But the love of music seems to exist for its own sake. The delights of melody and harmony do not obviously minister to the welfare either of the individual or of society. May we not suspect, however, that this exception is apparent only? Is it not a rational inquiry—What are the indirect benefits which accrue from music, in addition to the direct pleasure it gives?

But that it would take us too far out of our track, we should prelude this inquiry by illustrating at some length a certain general law of progress;—the law that alike in occupations, sciences, arts, the divisions which had a common root, but by gradual divergence have become distinct, and are now being separately developed, are not truly independent, but severally act and react on one another to their mutual advancement. Merely hinting thus much, however, by way of showing that there are many analogies to justify us, we go on to express the opinion that there exists a relationship of this kind between music and speech.

All speech is compounded of two elements, the words and the tones in which they are uttered—the signs of ideas and the signs of feelings. While certain articulations express the thought, certain modulations express the more or less of pain or pleasure which the thought gives. Using the word *cadence* in an unusually extended sense, as

comprehending all variations of voice, we may say that *cadence is the commentary of the emotions upon the propositions of the intellect.* This duality of spoken language, though not formally recognized, is recognized in practice by every one; and every one knows that very often more weight attaches to the tones than to the words. Daily experience supplies cases in which the same sentence of disapproval will be understood as meaning little or meaning much, according to the vocal inflections which accompany it; and daily experience supplies still more striking cases in which words and tones are in direct contradiction —the first expressing consent, while the last express reluctance; and the last being believed rather than the first.

These two distinct but interwoven elements of speech have been undergoing a simultaneous development. We know that in the course of civilization words have been multiplied, new parts of speech have been introduced, sentences have grown more varied and complex; and we may fairly infer that during the same time new modifications of voice have come into use, fresh intervals have been adopted, and cadences have become more elaborate. For while, on the one hand, it is absurd to suppose that, along with the undeveloped verbal forms of barbarism, there existed developed vocal inflections; it is, on the other hand, necessary to suppose that, along with the higher and more numerous verbal forms needed to convey the multiplied and complicated ideas of civilized life, there have grown up those more involved changes of voice which express the feelings proper to such ideas. If intellectual language is a growth, so also, without doubt, is emotional language a growth.

Now, the hypothesis which we have hinted above, is that, beyond the direct pleasure which it gives, music has the indirect effect of developing this language of the emotions. Having its root, as we have endeavoured to show, in those tones, intervals, and cadences of speech which express feel-

ing—arising by the combination and intensifying of these, and coming finally to have an embodiment of its own; music has all along been reacting upon speech, and increasing its power of rendering emotion. The use in recitative and song of inflections more expressive than ordinary ones, must from the beginning have tended to develope the ordinary ones. The complex musical phrases by which composers have conveyed complex emotions, may rationally be supposed to influence us in making those involved cadences of conversation by which we convey our subtler thoughts and feelings. If the cultivation of music has any effect on the mind, what more natural effect is there than this of developing our perception of the meanings of qualities, and modulations of voice; and giving us a correspondingly increased power of using them? Just as chemistry, arising out of the processes of metallurgy and the industrial arts, and gradually growing into an independent study, has now become an aid to all kinds of production—just as physiology, originating from medicine and once subordinate to it, but latterly pursued for its own sake, is in our day coming to be the science on which the progress of medicine depends;—so, music, having its root in emotional language, and gradually evolved from it, has ever been reacting upon and further advancing it.

It will scarcely be expected that much direct evidence in support of this conclusion can be given. The facts are of a kind which it is difficult to measure, and of which we have no records. Some suggestive traits, however, are to be noted. May we not say, for instance, that the Italians, among whom modern music was earliest cultivated, and who have more especially excelled in melody (the division of music with which our argument is chiefly concerned)—may we not say that these Italians speak in more varied and expressive inflections and cadences than any other people? On the other hand, may we not say that, confined almost exclusively as they have hitherto been to their national

airs, and therefore accustomed to but a limited range of musical expression, the Scotch are unusually monotonous in the intervals and modulations of their speech? And again, do we not find among different classes of the same nation, differences that have like implications? The gentleman and the clown stand in decided contrast with respect to variety of intonation. Listen to the conversation of a servant-girl, and then to that of a refined lady, and the more delicate and complex changes of voice used by the latter will be conspicuous. Now, without going so far as to say that out of all the differences of culture to which the upper and lower classes are subjected, difference of musical culture is that to which alone this difference of speech is ascribable; yet we may fairly say that there seems a much more obvious connexion of cause and effect between these than between any others. Thus, while the inductive evidence to which we can appeal is but scanty and vague, yet what there is favours our position.

Probably most will think that the function here assigned to music is one of very little moment. But reflection may lead them to a contrary conviction. In its bearings upon human happiness, this emotional language which musical culture develops and refines, is only second in importance to the language of the intellect; perhaps not even second to it. For these modifications of voice produced by feelings, are the means of exciting like feelings in others. Joined with gestures and expressions of face, they give life to the otherwise dead words in which the intellect utters its ideas; and so enable the hearer not only to *understand* the state of mind they accompany, but to *partake* of that state. In short, they are the chief media of *sympathy*. And if we consider how much both our general welfare and our immediate pleasures depend on sympathy, we shall recognize the importance of whatever makes this sympathy greater. If we bear in mind that by their fellow-feeling men are led

to behave justly and kindly to one another—that the difference between the cruelty of the barbarous and the humanity of the civilized, results from the increase of fellow-feeling; if we bear in mind that this faculty which makes us sharers in the joys and sorrows of others, is the basis of all the higher affections; if we bear in mind how much our direct gratifications are intensified by sympathy,—how, at the theatre, the concert, the picture gallery, we lose half our enjoyment if we have no one to enjoy with us;—we shall see that the agencies which communicate it can scarcely be overrated in value. The tendency of civilization is to repress the antagonistic elements of our characters and to develope the social ones—to curb our purely selfish desires and exercise our unselfish ones—to replace private gratifications by gratifications resulting from, or involving, the pleasures of others. And while, by this adaptation to the social state, the sympathetic side of our nature is being unfolded, there is simultaneously growing up a language of sympathetic intercourse—a language through which we communicate to others the happiness we feel, and are made sharers in their happiness. This double process, of which the effects are already appreciable, must go on to an extent of which we can as yet have no adequate conception. The habitual concealment of our feelings diminishing, as it must, in proportion as our feelings become such as do not demand concealment, the exhibition of them will become more vivid than we now dare allow it to be; and this implies a more expressive emotional language. At the same time, feelings of higher and more complex kinds, as yet experienced only by the cultivated few, will become general; and there will be a corresponding development of the emotional language into more involved forms. Just as there has silently grown up a language of ideas, which, rude as it at first was, now enables us to convey with precision the most subtle and complicated thoughts; so, there is still silently growing up a language of feelings, which, notwithstanding its present

imperfection, we may expect will ultimately enable men vividly and completely to impress on each other the emotions which they experience from moment to moment.

Thus if, as we have endeavoured to show, it is the function of music to facilitate the development of this emotional language, we may regard music as an aid to the achievement of that higher happiness which it indistinctly shadows forth. Those vague feelings of unexperienced felicity which music arouses—those indefinite impressions of an unknown ideal life which it calls up, may be considered as a prophecy, the fulfilment of which music itself aids. The strange capacity which we have for being affected by melody and harmony, may be taken to imply both that it is within the possibilities of our nature to realize those intenser delights they dimly suggest, and that they are in some way concerned in the realization of them. If so the power and the meaning of music become comprehensible; but otherwise they are a mystery.

We will only add that, if the probability of these corollaries be admitted, then music must take rank as the highest of the fine arts—as the one which, more than any other, ministers to human welfare. And thus, even leaving out of view the immediate gratifications it is hourly giving, we cannot too much applaud that musical culture which is becoming one of the characteristics of our age.

Postscript.

An opponent, or partial opponent, of high authority, whose views were published some fourteen years after the above essay, must here be answered: I mean Mr. Darwin. Diligent and careful as an observer beyond naturalists in general, and still more beyond those who are untrained in research, his judgment on a question which must be

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linear descendants of a faculty and pleasure which were musical and nothing else; and that, however rudely and tentatively applied to speech, Music was a *separate order*" (p. 492).

Thus, then, it is implied that the true germs of music stand towards developed music as the acorn to the oak. Now suppose we ask—How many traits of the oak are to be found in the acorn? Next to none. And then suppose we ask—How many traits of music are to be found in the tones of emotional speech? Very many. Yet while Mr. Gurney thinks that music had its origin in something which might have been as unlike it as the acorn is unlike the oak, he rejects the theory that it had its origin in something as much like it as the cadences of emotional speech; and he does this because there are sundry differences between the characters of speech-cadences and the characters of music. In the one case he tacitly assumes a great unlikeness between germ and product; while in the other case he objects because germ and product are not in all respects similar!

I may end by pointing out how extremely improbable, *a priori*, is Mr. Gurney's conception. He admits, as perforce he must, that emotional speech has various traits in common with recitative and song—relatively greater resonance, relatively greater loudness, more marked divergences from medium tones, the use of the extremes of pitch in signifying the extremes of feeling, and so on. But, denying that the one is derived from the others, he implies that these kindred groups of traits have had independent origins. Two sets of peculiarities in the use of the voice which show various kinships, have nothing to do with one another! I think it merely requires to put the proposition in this shape to see how incredible it is.

Sundry objections to the views contained in the essay on "The Origin and Function of Music," have arisen from misconception of its scope. An endeavour to explain the *origin* of music, has been dealt with as though it were a theory of music in its entirety. An hypothesis

concerning the rudiments has been rejected because it did not account for everything contained in the developed product. To preclude this misapprehension for the future, and to show how much more is comprehended in a theory of music than I professed to deal with, let me enumerate the several components of musical effect. They may properly be divided into *sensational, perceptional,* and *emotional.*

That the sensational pleasure is distinguishable from the other pleasures which music yields, will not be questioned. A sweet sound is agreeable in itself, when heard out of relation to other sounds. Tones of various *timbres,* too, are severally appreciated as having their special beauties. Of further elements in the sensational pleasure have to be named those which result from certain congruities between notes and immediately succeeding notes. This pleasure, like the primary pleasure which fine quality yields, appears to have a purely physical basis. We know that the agreeableness of simultaneous tones depends partly on the relative frequency of recurring correspondences of the vibrations producing them, and partly on the relative infrequency of beats, and we may suspect that there is a kindred cause for the agreeableness of successive tones; since the auditory apparatus which has been at one instant vibrating in a particular manner, will take up certain succeeding vibrations more readily than others. Evidently it is a question of the *degree* of congruity; for the most congruous vibrations, those of the octaves, yield less pleasure when heard in succession than those of which the congruity is not so great. To obtain the greatest pleasure in this and other things, there requires both likeness and difference. Recognition of this fact introduces us to the next element of sensational pleasure—that due to contrast; including contrast of pitch, of loudness, and of *timbre.* In this case, as in other cases, the disagreeableness caused by frequent repetition of the same sensation (here literally called "monotony") results from the exhaustion which any single

nervous agent undergoes from perpetual stimulation; and contrast gives pleasure because it implies action of an agent which has had rest. It follows that much of the sensational pleasure to be obtained from music depends on such adjustments of sounds as bring into play, without conflict, many nervous elements: exercising all and not over-exerting any. We must not overlook a concomitant effect. With the agreeable sensation is joined a faint emotion of an agreeable kind. Beyond the simple definite pleasure yielded by a sweet tone, there is a vague, diffused pleasure. As indicated in the *Principles of Psychology* (§537), each nervous excitation produces reverberation throughout the nervous system at large; and probably this indefinite emotional pleasure is a consequence. Doubtless some shape is given to it by association. But after observing how much there is in common between the diffused feeling aroused by smelling at a deliciously scented flower and that aroused by listening to a sweet tone, it will, I think, be perceived that the more general cause predominates.

The division between the sensational effects and the perceptional effects is of course indefinite. As above implied, part of the sensational pleasure depends on the relation between each tone and the succeeding tone; and hence this pleasure gradually merges into that which arises from perceiving the structural connexions between the phrases and between the larger parts of musical compositions. Much of the gratification given by a melody consists in the consciousness of the relations between each group of sounds heard and the groups of sounds held in memory as having just passed, as well as those represented as about to come. In many cases the passage listened to would not be regarded as having any beauty were it not for its remembered connexions with passages in the immediate past and the immediate future. If, for example, from the first movement of Beethoven's Funeral-March sonata the first five notes are detached, they appear to be meaningless;

but if, the movement being known, they are joined with imaginations of the anticipated phrases, they immediately acquire meaning and beauty. Indefinable as are the causes of this perceptional pleasure in many cases, some causes of it are definable. Symmetry is one. A chief element in melodic effect results from repetitions of phrases which are either identical, or differ only in pitch, or differ only in minor variations: there being in the first case the pleasure derived from perception of complete likeness, and in the other cases the greater pleasure derived from perception of likeness with difference—a perception which is more involved, and therefore exercises a greater number of nervous agents. Next comes, as a source of gratification, the consciousness of pronounced unlikeness or contrast; such as that between passages above the middle tones and passages below, or as that between ascending phrases and descending phrases. And then we rise to larger contrasts; as when, the first theme in a melody having been elaborated, there is introduced another having a certain kinship though in many respects different, after which there is a return to the first theme: a structure which yields more extensive and more complex perceptions of both differences and likenesses. But while perceptional pleasures include much that is of the highest, they also include much that is of the lowest. A certain kind of interest, if not of beauty, is producible by the likenesses and contrasts of musical phrases which are intrinsically meaningless or even ugly. A familiar experience exemplifies this. If a piece of paper is folded and on one side of the crease there is drawn an irregular line in ink, which, by closing the paper, is blotted on the opposite side of the crease, there results a figure which, in virtue of its symmetry, has some beauty; no matter how entirely without beauty the two lines themselves may be. Similarly, some interest results from the parallelism of musical phrases, notwithstanding utter lack of interest in the phrases themselves. The kind of interest

resulting from such parallelisms, and from many contrasts, irrespective of any intrinsic worth in their components, is that which is most appreciated by the musically-uncultured, and gives popularity to miserable drawing-room ballads and vulgar music-hall songs.

The remaining element of musical effect consists in the idealized rendering of emotion. This, as I have sought to show, is the primitive element, and will ever continue to be the vital element; for if "melody is the soul of music," then expression is the soul of melody—the soul without which it is mechanical and meaningless, whatever may be the merit of its form. This primitive element may with tolerable clearness be distinguished from the other elements, and may coexist with them in various degrees: in some cases being the predominant element. Anyone who, in analytical mood, listens to such a song as *Robert, toi que j'aime*, cannot, I think, fail to perceive that its effectiveness depends on the way in which it exalts and intensifies the traits of passionate utterance. No doubt as music develops, the emotional element (which affects structure chiefly through the forms of phrases) is increasingly complicated with, and obscured by, the perceptional element; which both modifies these phrases and unites them into symmetrical and contrasted combinations. But though the groups of notes which emotion prompts admit of elaboration into structures that have additional charms due to artfully-arranged contrasts and repetitions, the essential element is liable to be thus submerged in the non-essential. Only in melodies of high types, such as the *Addio* of Mozart and *Adelaide* of Beethoven, do we see the two requirements simultaneously fulfilled. Musical genius is shown in achieving the decorative beauty without losing the beauty of emotional meaning.

It goes without saying that there must be otherwise accounted for that relatively modern element in musical effect which has now almost outgrown in importance the

other elements—I mean harmony. This cannot be affiliated on the natural language of emotion; since, in such language, limited to successive tones, there cannot originate the effects wrought by simultaneous tones. Dependent as harmony is on relations among rates of aerial pulses, its primary basis is purely mechanical; and its secondary basis lies in the compound vibrations which certain combinations of mechanical rhythms cause in the auditory apparatus. The resulting pleasure must, therefore, be due to nervous excitations of kinds which, by their congruity, exalt one another; and thus generate a larger volume of agreeable sensation. A further pleasure of sensational origin which harmony yields is due to contrapuntal effects. Skilful counterpoint has the general character that it does not repeat in immediate succession similar combinations of tones and similar directions of change; and by thus avoiding temporary over-tax of the nervous structures brought into action, keeps them in better condition for subsequent action. Absence of regard for this requirement characterizes the music of Gluck, of whom Handel said—"He knows no more counterpoint than my cook;" and it is this disregard which produces its cloying character. Respecting the effects of harmony I will add only that the vague emotional accompaniment to the sensation produced by a single sweet tone, is paralleled by the stronger emotional accompaniment to the more voluminous and complex sensation produced by a fine chord. Clearly this vague emotion forms a large component in the pleasure which harmony gives.

While thus recognizing, and indeed emphasizing, the fact that of many traits of developed music my hypothesis respecting the origin of music yields no explanation, let me point out that this hypothesis gains a further general support from its conformity to the law of evolution. Progressive integration is seen in the immense contrast between the small combinations of tones constituting a cadence of grief, or anger, or triumph, and the vast combinations of

tones, simultaneous and successive, constituting an oratorio. Great advance in coherence becomes manifest when, from the lax unions among the sounds in which feeling spontaneously expresses itself, or even from those few musical phrases which constitute a simple air, we pass to those elaborate compositions in which portions small and large are tied together into extended organic wholes. On comparing the unpremeditated inflexions of the voice in emotional speech, vague in tones and times, with those premeditated ones which the musician arranges for stage or concert room, in which the divisions of time are exactly measured, the successive intervals precise, and the harmonies adjusted to a nicety, we observe in the last a far higher definiteness. And immense progress in heterogeneity is seen on putting side by side the monotonous chants of savages with the musical compositions familiar to us; each of which is relatively heterogeneous within itself, and the assemblage of which forms an immeasurably heterogeneous aggregate.

Strong support for the theory enunciated in this essay, and defended in the foregoing paragraphs, is furnished by the testimonies of two travellers in Hungary, given in works published in 1878 and 1888 respectively. Here is an extract from the first of the two.

"Music is an instinct with these Hungarian gipsies. They play by ear, and with a marvellous precision, not surpassed by musicians who have been subject to the most careful training. . . . The airs they play are most frequently compositions of their own, and are in character quite peculiar. . . I heard on this occasion one of the gipsy airs which made an indelible impression on my mind; it seemed to me the thrilling utterance of a people's history. There was the low wail of sorrow, of troubled passionate grief, stirring the heart to restlessness, then the sense of turmoil and defeat; but upon this breaks suddenly a wild burst of exultation, of rapturous joy—a triumph achieved, which hurries you along with it in resistless sympathy. The excitable Hungarians can literally become intoxicated with this music—and no wonder. You cannot reason upon it, or explain it, but its strains compel you to sensations of despair and joy, of exultation and excitement, as though under the influence of some potent charm."—*Round about the Carpathians*, by Andrew F. Crosse, pp. 11, 12.

Still more graphic and startling is the description given by a more recent traveller, E. Gerard.

"Devoid of printed notes, the Tzigane is not forced to divide his attention between a sheet of paper and his instrument, and there is consequently nothing to detract from the utter abandonment with which he absorbs himself in his playing. He seems to be sunk in an inner world of his own; the instrument sobs and moans in his hands, and is pressed tight against his heart as though it had grown and taken root there. This is the true moment of inspiration, to which he rarely gives way, and then only in the privacy of an intimate circle, never before a numerous and unsympathetic audience. Himself spell-bound by the power of the tones he evokes, his head gradually sinking lower and lower over the instrument, the body bent forward in an attitude of rapt attention, and his ear seeming to hearken to far-off ghostly strains audible to himself alone, the untaught Tzigane achieves a perfection of expression unattainable by mere professional training.

This power of identification with his music is the real secret of the Tzigane's influence over his audience. Inspired and carried away by his own strains, he must perforce carry his hearers with him as well; and the Hungarian listener throws himself heart and soul into this species of musical intoxication, which to him is the greatest delight on earth. There is a proverb which says, 'The Hungarian only requires a gipsy fiddler and a glass of water in order to make him quite drunk;' and, indeed, intoxication is the only word fittingly to describe the state of exaltation into which I have seen a Hungarian audience thrown by a gipsy band.

Sometimes, under the combined influence of music and wine, the Tziganes become like creatures possessed; the wild cries and stamps of an equally excited audience only stimulate them to greater exertions. The whole atmosphere seems tossed by billows of passionate harmony; we seem to catch sight of the electric sparks of inspiration flying through the air. It is then that the Tzigane player gives forth everything that is secretly lurking within him—fierce anger, childish wailings, presumptuous exaltation, brooding melancholy, and passionate despair; and at such moments, as a Hungarian writer has said, one could readily believe in his power of drawing down the angels from heaven into hell!

Listen how another Hungarian has here described the effect of their music:—'How it rushes through the veins like electric fire! How it penetrates straight to the soul! In soft plaintive minor tones the *adagio* opens with a slow rhythmical movement: it is a sighing and longing of unsatisfied aspirations; a craving for undiscovered happiness; the lover's yearning for the object of his affection; the expression of mourning for lost joys, for happy days gone for ever; then abruptly changing to a major key, the tones get faster and more agitated; and from the whirlpool of harmony the melody gradually detaches itself, alternately drowned in the foam of overbreaking waves, to reappear floating on the surface with undulating motion—collecting as it were fresh power for a renewed burst of fury. But

quickly as the storm came it is gone again, and the music relapses into the melancholy yearnings of heretofore.'" *The Land beyond the Forest*, vol. II, pp. 122-4. Lond. 1888.

After the evidence thus furnished, argument is almost superfluous. The origin of music as the developed language of emotion seems to be no longer an inference but simply a description of the fact.

THE PHYSIOLOGY OF LAUGHTER.

[*First published in* Macmillan's Magazine *for March* 1860.]

WHY do we smile when a child puts on a man's hat? or what induces us to laugh on reading that the corpulent Gibbon was unable to rise from his knees after making a tender declaration? The usual reply to such questions is, that laughter results from a perception of incongruity. Even were there not, on this reply, the obvious criticism that laughter often occurs from extreme pleasure or from mere vivacity, there would still remain the real problem—How comes a sense of the incongruous to be followed by these peculiar bodily actions? Some have alleged that laughter is due to the pleasure of a relative self-elevation, which we feel on seeing the humiliation of others. But this theory, whatever portion of truth it may contain, is, in the first place, open to the fatal objection that there are various humiliations to others which produce in us anything but laughter; and, in the second place, it does not apply to the many instances in which no one's dignity is implicated: as when we laugh at a good pun. Moreover, like the other, it is merely a generalization of certain conditions to laughter; and not an explanation of the odd movements which occur under these conditions. Why, when greatly delighted, or impressed with certain unexpected contrasts;

of ideas, should there be a contraction of particular facial muscles and particular muscles of the chest and abdomen? Such answer to this question as may be possible, can be rendered only by physiology.

Every child has made the attempt to hold the foot still while it is tickled, and has failed; and there is scarcely any one who has not vainly tried to avoid winking when a hand has been suddenly passed before the eyes. These examples of muscular movements which occur independently of the will, or in spite of it, illustrate what physiologists call reflex-action; as likewise do sneezing and coughing. To this class of cases, in which involuntary motions are accompanied by sensations, has to be added another class of cases, in which involuntary motions are unaccompanied by sensations:—instance the pulsations of the heart; the contractions of the stomach during digestion. Further, the majority of seemingly-voluntary acts in such creatures as insects, worms, molluscs, are considered by physiologists to be as purely automatic as is the dilatation or closure of the iris under variations in the quantity of light; and similarly exemplify the law, that an impression on the end of an afferent nerve is conveyed to some ganglionic centre, and is thence usually reflected along an efferent nerve to one or more muscles which it causes to contract.

In a modified form this principle holds with voluntary acts. Nervous excitation always *tends* to beget muscular motion; and when it rises to a certain intensity always does beget it. Not only in reflex actions, whether with or without sensation, do we see that special nerves, when raised to states of tension, discharge themselves on special muscles with which they are indirectly connected; but those external actions through which we read the feelings of others, show us that, under any considerable tension, the nervous system in general discharges itself on the muscular system in general: either with or without the

guidance of the will. The shivering produced by cold implies irregular muscular contractions, which, though at first only partly involuntary, become, when the cold is extreme, almost wholly involuntary. When you have severely burnt your finger it is very difficult to preserve a dignified composure: contortion of face, or movement of limb, is pretty sure to follow. If a man receives good news with neither facial change nor bodily motion, it is inferred that he is not much pleased, or that he has extraordinary self-control: either inference implying that joy almost universally produces contraction of the muscles, and so, alters the expression, or attitude, or both. And when we hear of the feats of strength which men have performed when their lives were at stake—when we read how, in the energy of despair, even paralyzed patients have regained for a time the use of their limbs; we see still more clearly the relation between nervous and muscular excitements. It becomes manifest both that emotions and sensations tend to generate bodily movements, and that the movements are violent in proportion as the emotions or sensations are intense.*

This, however, is not the sole direction in which nervous excitement expends itself. Viscera as well as muscles may receive the discharge. That the heart and blood-vessels (which, indeed, being all contractile, may in a restricted sense be classed with the muscular system) are quickly affected by pleasures and pains, we have daily proved to us. Every sensation of any acuteness accelerates the pulse; and how sensitive the heart is to emotions, is testified by the familiar expressions which use heart and feeling as convertible terms. Similarly with the digestive organs. Without detailing the various ways in which these may be influenced by our mental states, it suffices to mention the marked benefits derived by dyspeptics, as well as other invalids, from cheerful society, welcome news,

* For numerous illustrations see essay on "The Origin and Function of Music."

change of scene, to show how pleasurable feeling stimulates the viscera in general into greater activity.

There is still another direction in which any excited portion of the nervous system may discharge itself; and a direction in which it usually does discharge itself when the excitement is not strong. It may pass on the stimulus to some other portion of the nervous system. This is what occurs in quiet thinking and feeling. The successive states which constitute consciousness, result from this. Sensations excite ideas and emotions; these in their turns arouse other ideas and emotions; and so on continuously. That is to say, the tension existing in particular nerve-centres, or groups of nerve-centres, when they yield us certain sensations, ideas, or emotions, generates an equivalent tension in some other nervous structures, with which there is a connexion: the flow of energy passing on, the one idea or feeling dies in producing the next.

Thus, then, while we are totally unable to comprehend how the excitement of certain nerve-centres should generate feeling—while, in the production of consciousness by physical agents acting on physical structures, we come to a mystery never to be solved; it is yet quite possible for us to know by observation what are the successive forms which this mystery may take. We see that there are three channels along which nerve-centres in a state of tension may discharge themselves; or rather, I should say, three classes of channels. They may pass on the excitement to other nerve-centres that have no direct connexions with the bodily members, and may so cause other feelings and ideas; or they may pass on the excitement to one or more motor nerves, and so cause muscular contractions; or they may pass on the excitement to nerves which supply the viscera, and may so stimulate one or more of these.

For simplicity's sake I have described these as alternative routes, one or other of which any current of nerve-force must take; thereby, as it may be thought, implying that

such current will be exclusively confined to some one of them. But this is by no means the case. Rarely, if ever, does it happen that a state of nervous tension, present to consciousness as a feeling, expends itself in one direction only. Very generally it may be observed to expend itself in two; and it is probable that the discharge is never absolutely absent from any one of the three. There is, however, variety in the *proportions* in which the discharge is divided among these different channels under different circumstances. In a man whose fear impels him to run, the mental tension generated is only in part transformed into a muscular stimulus: there is a surplus which causes a rapid current of ideas. An agreeable state of feeling produced, say by praise, is not wholly used up in arousing the succeeding phase of the feeling and the new ideas appropriate to it; but a certain portion overflows into the visceral nervous system, increasing the action of the heart and facilitating digestion. And here we come upon a class of considerations and facts which open the way to a solution of our special problem.

For, starting with the truth that at any moment the existing quantity of liberated nerve-force which in an inscrutable way produces in us the state we call feeling, *must* expend itself in some direction, it follows that, if of the several channels it may take, one is wholly or partially closed, more must be taken by the others; or that if two are closed, the discharge along the remaining one must be more intense; and that, conversely, should anything determine an unusual efflux in one direction, there will be a diminished efflux in other directions.

Daily experience illustrates these conclusions. It is commonly remarked that the suppression of external signs of feeling, makes feeling more intense. The deepest grief is silent grief. Why? Because the nervous excitement not discharged in muscular action, discharges itself in other nervous excitements—arouses more numerous and more

remote associations of melancholy ideas, and so increases the mass of feelings. People who conceal their anger are habitually found to be more revengeful than those who explode in loud speech and vehement action. Why? Because, as before, the emotion is reflected back, accumulates, and intensifies. Similarly, men who, as proved by their powers of representation, have the keenest appreciation of the comic, are usually able to do and say the most ludicrous things with perfect gravity.

On the other hand, all are familiar with the truth that bodily activity deadens emotion. Under great irritation we get relief by walking about rapidly. Extreme effort in the bootless attempt to achieve a desired end, greatly diminishes the intensity of the desire. Those who are forced to exert themselves after misfortunes, do not suffer nearly so much as those who remain quiescent. If any one wishes to check intellectual excitement, he cannot choose a more efficient method than running till he is exhausted. Moreover, these cases, in which the production of feeling and thought is hindered by determining the nervous energy towards bodily movements, have their counterparts in the cases in which bodily movements are hindered by extra absorption of nervous energy in sudden thoughts and feelings. If, when walking, there flashes on you an idea that creates great surprise, hope, or alarm, you stop; or if sitting cross-legged, swinging your pendent foot, the movement is at once arrested. From the viscera, too, intense mental action abstracts energy. Joy, disappointment, anxiety, or any moral perturbation rising to a great height, destroys appetite; or, if food has been taken, arrests digestion; and even a purely intellectual activity, when extreme, does the like.

Facts, then, bear out these *a priori* inferences, that the nervous excitement at any moment present to consciousness as feeling, must expend itself in some way or other; that of the three classes of channels open to it, it must

take one, two, or more, according to circumstances; that the closure or obstruction of one, must increase the discharge through the others; and, conversely, that if, to answer some demand, the efflux of nervous energy in one direction is unusually great, there must be a corresponding decrease of the efflux in other directions. Setting out from these premises, let us now see what interpretation is to be put on the phenomena of laughter.

That laughter is a form of muscular excitement, and so illustrates the general law that feeling passing a certain pitch habitually vents itself in bodily action, scarcely needs pointing out. It perhaps needs pointing out, however, that strong feeling of almost any kind produces this result. It is not a sense of the ludicrous, only, which does it; nor are the various forms of joyous emotion the sole additional causes. We have, besides, the sardonic laughter and the hysterical laughter which result from mental distress; to which must be added certain sensations, as tickling, and, according to Mr. Bain, cold, and some kinds of acute pain.

Strong feeling, mental or physical, being, then, the general cause of laughter, we have to note that the muscular actions constituting it are distinguished from most others by this, that they are purposeless. In general, bodily motions that are prompted by feelings are directed to special ends; as when we try to escape a danger, or struggle to secure a gratification. But the movements of chest and limbs which we make when laughing have no object. And now remark that these quasi-convulsive contractions of the muscles, having no object, but being results of an uncontrolled discharge of energy, we may see whence arise their special characters—how it happens that certain classes of muscles are affected first, and then certain other classes. For an overflow of nerve-force undirected by any motive, will manifestly take first the

most habitual routes; and if these do not suffice, will next overflow into the less habitual ones. Well, it is through the organs of speech that feeling passes into movement with the greatest frequency. The jaws, tongue, and lips are used not only to express strong irritation or gratification, but that very moderate flow of mental energy which accompanies ordinary conversation, finds its chief vent through this channel. Hence it happens that certain muscles round the mouth, small and easy to move, are the first to contract under pleasurable emotion. The class of muscles which, next after those of articulation, are most constantly set in action (or extra action, let us say) by feelings of all kinds, are those of respiration. Under pleasurable or painful sensations we breathe more rapidly: possibly as a consequence of the increased demand for oxygenated blood. The sensations that accompany exertion also bring on hard breathing; which here more evidently responds to the physiological needs. And emotions, too, agreeable and disagreeable, both, at first, excite respiration; though the last subsequently depress it. That is to say, of the bodily muscles, the respiratory are more constantly implicated than any others in those various acts which our feelings impel us to; and, hence, when there occurs an undirected discharge of nervous energy into the muscular system, it happens that, if the quantity be considerable, it convulses not only certain of the articulatory and vocal muscles, but also those which expel air from the lungs. Should the feeling to be expended be still greater in amount—too great to find vent in these classes of muscles—another class comes into play. The upper limbs are set in motion. Children frequently clap their hands in glee; by some adults the hands are rubbed together; and others, under still greater intensity of delight, slap their knees and sway their bodies backwards and forwards. Last of all, when the other channels for the escape of the surplus nerve-force have been filled to

overflowing, a yet further and less-used group of muscles is spasmodically affected: the head is thrown back and the spine bent inwards—there is a slight degree of what medical men call opisthotonos. Thus, then, without contending that the phenomena of laughter in all their details are to be so accounted for, we see that in their *ensemble* they conform to these general principles:—that feeling excites to muscular action; that when the muscular action is unguided by a purpose the muscles first affected are those which feeling most habitually stimulates; and that as the feeling to be expended increases in quantity it excites an increasing number of muscles, in a succession determined by the relative frequency with which they respond to the regulated dictates of feeling. To which as a qualifying and complicating factor must be added the relative sizes of the muscles; since, other things equal, the smaller muscles will be moved more readily than the larger.

There still, however, remains the question with which we set out. The explanation here given applies only to the laughter produced by acute pleasure or pain: it does not apply to the laughter which follows certain perceptions of incongruity. It is an insufficient explanation that in these cases, laughter is a result of the pleasure we take in escaping from the restraint of grave feelings. That this is a part-cause is true. Doubtless very often, as Mr. Bain says, "it is the coerced form of seriousness and solemnity without the reality that gives us that stiff position from which a contact with triviality or vulgarity relieves us, to our uproarious delight." And in so far as mirth is caused by the gush of agreeable feeling which follows the cessation of unpleasant mental strain, it further illustrates the general principle above set forth. But no explanation is thus afforded of the mirth which ensues when the short silence between the *andante* and *allegro* in one of Beethoven's symphonies, is broken by a loud sneeze. In this, and hosts of like cases, the mental tension is not coerced but spon-

taneous—not disagreeable but agreeable; and the coming impressions to which attention is directed, promise a gratification which few, if any, desire to escape. Hence, when the unlucky sneeze occurs, it cannot be that the laughter of the audience is due simply to the release from an irksome attitude of mind: some other cause must be sought.

This cause we shall arrive at by carrying our analysis a step further. We have but to consider the quantity of feeling which exists under such circumstances, and then to ask what are the conditions determining the direction of its discharge, to reach a solution. Take a case. You are sitting in a theatre, absorbed in the progress of an interesting drama. Some climax has been reached which has aroused your sympathies—say, a reconciliation between the hero and heroine, after long and painful misunderstanding. The feelings excited by this scene are not of a kind from which you seek relief; but are, on the contrary, a grateful relief from the painful feelings with which you have witnessed the previous estrangement. Moreover, the sentiments these fictitious personages have for the moment inspired you with, are not such as would lead you to rejoice in any indignity offered to them; but rather, such as would make you resent the indignity. And now, while you are contemplating the reconciliation with a pleasurable sympathy, there appears from behind the scenes a tame kid, which, having stared round at the audience, walks up to the lovers and sniffs at them. You cannot help joining in the roar which greets this *contretemps*. Inexplicable as is this irresistible burst on the hypothesis of a pleasure in escaping from mental restraint; or on the hypothesis of a pleasure from relative increase of self-importance, when witnessing the humiliation of others; it is readily explicable if we consider what, in such a case, must become of the feeling that existed at the moment the incongruity arose. A large mass of emotion had been produced; or, to speak in physiological language, a large portion of the nervous

system was in a state of tension. There was also great expectation with respect to the further evolution of the scene —a quantity of vague, nascent thought and emotion, into which the existing quantity of thought and emotion was about to pass. Had there been no interruption, the body of new ideas and feelings next excited, would have sufficed to absorb the whole of the liberated nervous energy. But now, this large amount of nervous energy, instead of being allowed to expend itself in producing an equivalent amount of the new thoughts and emotions which were nascent, is suddenly checked in its flow. The channels along which the discharge was about to take place, are closed. The new channel opened—that afforded by the appearance and proceedings of the kid—is a small one; the ideas and feelings suggested are not numerous and massive enough to carry off the nervous energy to be expended. The excess must therefore discharge itself in some other direction; and in the way already explained, there results an efflux through the motor nerves to various classes of the muscles, producing the half-convulsive actions we term laughter.

This explanation is in harmony with the fact that when, among several persons who witness the same ludicrous occurrence, there are some who do not laugh, it is because there has arisen in them an emotion not participated in by the rest, and which is sufficiently massive to absorb all the nascent excitement. Among the spectators of an awkward tumble, those who preserve their gravity are those in whom there is excited a degree of sympathy with the sufferer, sufficiently great to serve as an outlet for the feeling which the occurrence had turned out of its previous course. Sometimes anger carries off the arrested current; and so prevents laughter. An instance of this was lately furnished me by a friend who had been witnessing the feats at Franconi's. A tremendous leap had just been made by an acrobat over a number of horses. The clown, seemingly envious of this success, made ostentatious preparation for doing the like;

and then, taking the preliminary run with immense energy, stopped short on reaching the first horse, and pretended to wipe some dust from its haunches. In most of the spectators, merriment was excited; but in my friend, wound up by the expectation of the coming leap to a state of great nervous tension, the effect of the baulk was to produce indignation. Experience thus proves what the theory implies; namely, that the discharge of arrested feelings into the muscular system, takes place only in the absence of other adequate channels—does not take place if there arise other feelings equal in amount to those arrested.

Evidence still more conclusive is at hand. If we contrast the incongruities which produce laughter with those which do not, we see that in the non-ludicrous ones the unexpected feeling aroused, though wholly different in kind, is not less in quantity or intensity. Among incongruities which may excite anything but a laugh, Mr. Bain instances —"A decrepit man under a heavy burden, five loaves and two fishes among a multitude, and all unfitness and gross disproportion; an instrument out of tune, a fly in ointment, snow in May, Archimedes studying geometry in a siege, and all discordant things; a wolf in sheep's clothing, a breach of bargain, and falsehood in general; the multitude taking the law in their own hands, and everything of the nature of disorder; a corpse at a feast, parental cruelty, filial ingratitude, and whatever is unnatural; the entire catalogue of the vanities given by Solomon, are all incongruous, but they cause feelings of pain, anger, sadness, loathing, rather than mirth." Now in these cases, where the totally unlike state of consciousness suddenly produced, is not inferior in mass to the preceding one, the conditions to laughter are not fulfilled. As above shown, laughter naturally results only when consciousness is unawares transferred from great things to small—only when there is what we may call a *descending* incongruity.

And now observe, finally, the fact, alike inferable *a priori*

and illustrated in experience, that an *ascending* incongruity not only fails to cause laughter, but works on the muscular system an effect of the reverse kind. When after something very insignificant there arises without anticipation something very great, the emotion we call wonder results; and this emotion is accompanied not by contraction of the muscles, but by relaxation of them. In children and country people, that falling of the jaw which occurs on witnessing an imposing and unexpected change, exemplifies this effect. Persons wonder-struck at the production of a striking result by a seemingly-inadequate cause, are frequently described as unconsciously dropping the things they held in their hands. Such are just the effects to be anticipated. After an average state of consciousness, absorbing but a small quantity of nervous energy, is aroused without notice, a strong emotion of awe, terror, or admiration; joined with the astonishment due to an apparent want of adequate causation. This new state of consciousness demands far more nervous energy than that which it has suddenly replaced; and this increased absorption of nervous energy in mental changes, involves a temporary diminution of the outflow in other directions: whence the pendent jaw and the relaxing grasp.

One further observation is worth making. Among the several sets of channels into which surplus feeling might be discharged, was named the nervous system of the viscera. The sudden overflow of an arrested mental excitement, which, as we have seen, results from a descending incongruity, must doubtless stimulate not only the muscular system, as we see it does, but also the internal organs: the heart and stomach must come in for a share of the discharge. And thus there seems to be a good physiological basis for the popular notion that mirth-creating excitement facilitates digestion.

Though, in doing so, I go beyond the boundaries of the

immediate topic, I may fitly point out that the method of inquiry here followed, opens the way to interpretation of various phenomena besides those of laughter. To show the importance of pursuing it, I will indicate the explanation it furnishes of another familiar class of facts.

All know how generally a large amount of emotion disturbs the action of the intellect, and interferes with the power of expression. A speech delivered with great facility to tables and chairs, is by no means so easily delivered to an audience. Every schoolboy can testify that his trepidation, when standing before a master, has often disabled him from repeating a lesson which he had duly learnt. In explanation of this we commonly say that the attention is distracted —that the proper train of ideas is broken by the intrusion of ideas that are irrelevant. But the question is, in what manner does unusual emotion produce this effect; and we are here supplied with a tolerably obvious answer. The repetition of a lesson, or set speech previously thought out, implies the flow of a very moderate amount of nervous excitement through a comparatively narrow channel. The thing to be done is simply to call up in succession certain previously-arranged ideas—a process in which no great amount of mental energy is expended. Hence, when there is a large quantity of emotion, which must be discharged in some direction or other; and when, as usually happens, the restricted series of intellectual actions to be gone through, does not suffice to carry it off; there result discharges along other channels besides the one prescribed: there are aroused various ideas foreign to the train of thought to be pursued; and these tend to exclude from consciousness those which should occupy it.

And now observe the meaning of those bodily actions spontaneously set up under these circumstances. The schoolboy saying his lesson, commonly has his fingers actively engaged—perhaps in twisting about a broken pen, or perhaps in squeezing the angle of his jacket; and if told to keep his

hands still, he soon again falls into the same or a similar trick. Many anecdotes are current of public speakers having incurable automatic actions of this class: barristers who perpetually wound and unwound pieces of tape; members of parliament ever putting on and taking off their spectacles. So long as such movements are unconscious, they facilitate the mental actions. At least this seems a fair inference from the fact that confusion frequently results from putting a stop to them: witness the case narrated by Sir Walter Scott of his school-fellow, who became unable to say his lesson after the removal of the waistcoat button which he habitually fingered while in class. But why do they facilitate the mental actions? Clearly because they draw off a portion of the surplus nervous excitement. If, as above explained, the quantity of mental energy generated is greater than can find vent along the narrow channel of thought that is open to it; and if, in consequence, it is apt to produce confusion by rushing into other channels of thought; then, by allowing it an exit through the motor nerves into the muscular system, the pressure is diminished, and irrelevant ideas are less likely to intrude on consciousness.

This further illustration will, I think, justify the position that something may be achieved by pursuing in other cases this kind of psychological inquiry. A complete explanation of the phenomena, requires us to trace out *all* the consequences of any given state of consciousness; and we connot do this without studying the effects, bodily and mental, as varying in quantity at one another's expense. We should probably learn much if in every case we asked —Where is all the nervous energy gone?

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